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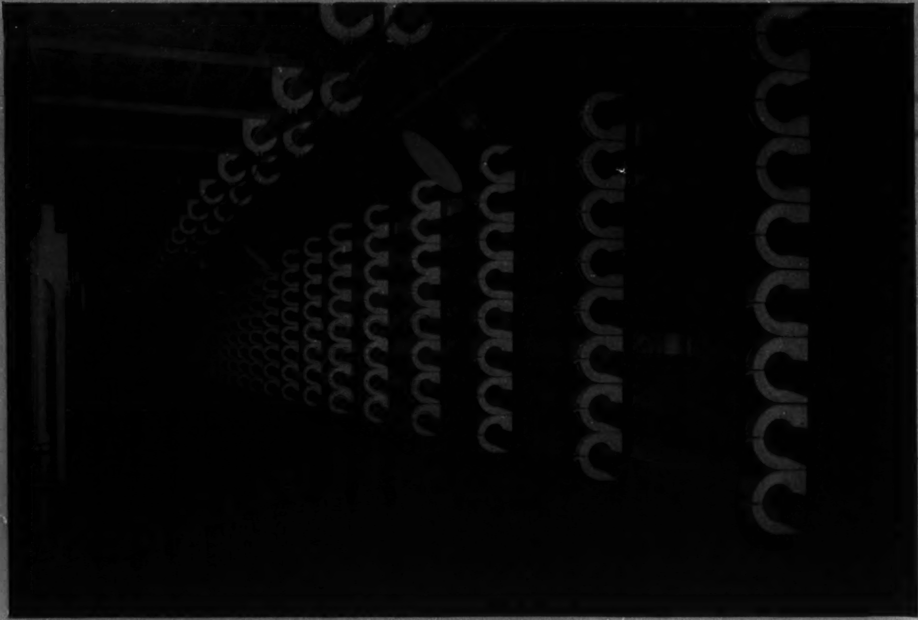

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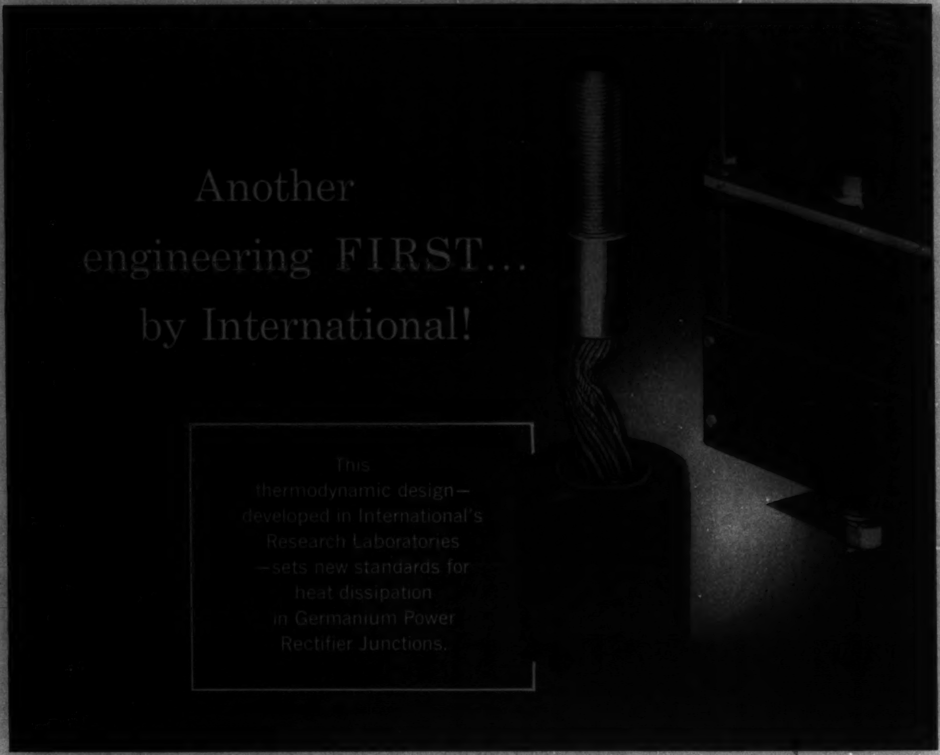

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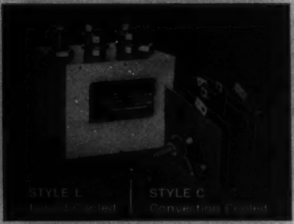

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PROGRESS IN ENGINEERING

During 1955—Reviewed by AIEE Technical Committees

MAJOR ADVANCEMENTS have been made by electrical engineers in 1955 in the five fields of activities, as reported by numerous AIEE technical committees.

In the communications field, growth in color television broadcasting occurred, so that in the United States there are now more than 300 stations equipped to transmit network color, 20 stations to originate live color, and 65 to originate color film. Schools as well as the military have installed closed-circuit television. Some 55,000 route miles of microwave radio systems are now in use for telephone, television, telemetering, telegraph, and related facilities. The Bell System is developing an automatic teletypewriter switching system for military use capable of employing line speeds up to 100 words per minute. New applications include a code converter to allow interconnection between telegraph systems of United States and Europe to take care of code and speed differences, as well as information-retrieval and language-translation systems.

Improvements in artificial-light sources include high-output rapid-start fluorescent lamps, more efficient weather-duty mercury lamps, and smaller incandescent lamps. Supplementary electric heating units for installation in furnaces during spring and fall seasons are an efficient addition.

In the industrial field, a new economical carbon dioxide gas-shielding process for welding steel has been widely adopted; high-frequency resistance heating has been found to be practical in fabricating welded metal tubing; automatic gauge control systems have been placed in operation in reduction mills in the metal industry; and a larger sealed ignitron has found many practical applications.

Notable improvements in the power field include a major reduction in power-line carrier-current channel bandwidth, as well as reduction in the apparatus through the use of transistors. Cooling of large turbine generators by gaseous or liquid coolants has been successful. Circuit breakers with easily removed arc chutes to facilitate maintenance have been designed; two revolutionary gas-insulated transformers have been completed. Newly developed a-c network analyzers and digital computers now evaluate power-line losses.

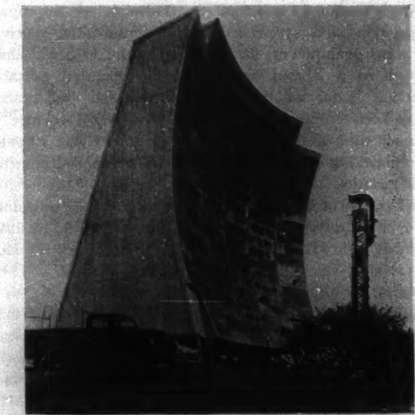
In scientific and electronics activities, 1955 marks the start of wide uses of digital computers for business applications. All-transistor computers were constructed, some utilizing magnetic-core memories. The solar battery, announced as a research item last year, was put into service. In the industrial electronics field, automation was put into practice for mass production; automatic programming systems operate from magnetic tape to permit hours of preplanned operation. Significant developments have been made in the field of nuclear instrumentation, including decade counting tubes and high-speed pulse-height analyzers. Forty-two nuclear reactors for production of power, materials testing, or research are in use or in advanced stages of construction in 8 countries.

Communication

RADIO SYSTEMS

THE YEAR 1955 was marked by continued expansion of the use of microwave radio for both public and industrial communications. There are now in operation in the United States some 55,000 route miles of such microwave systems providing over 9-million miles of telephone circuits, 55,000 miles of television circuits, and thousands of miles of telemetering, telegraph, and related facilities. The new horn-reflector antenna made its appearance for the first time during the year on some new microwave routes. This antenna is capable of handling simultaneously signals in the 4,000-, 6,000-, and 11,000-mc common-carrier bands, thus providing for future growth of facilities on these routes.

The year also saw application for military purposes of the recently discovered radio-propagation phenomena of tropospheric and ionospheric scatter for long-range transmission on frequencies above 40 mc. Tests were conducted for 6 months between Homestead, Fla., and a site near Havana,



Sixty-foot antenna planned for Florida–Cuba uhf broadband tropospheric scatter system

Portable direction finder for 200 to 3,400 kc

Cuba, for a commercial tropospheric-scatter multichannel link to go into service during 1956.

Other similar commercial multichannel systems are planned for service between Sardinia and Minorca in the Mediterranean, between Puerto Rico and Hispaniola in the West Indies, and between Goose Bay, Labrador, and Rimouski, Quebec, in Canada.

Increasing growth of vhf mobile radio communication systems along turnpikes and toll roads in the United States occurred during 1955. There are now in operation some 1,300 miles of toll highways, with another 1,000 miles under construction. The communications systems for these highways usually comprise a series of base stations at strategic locations for 2-way communication with patrol and maintenance vehicles, the base stations being interconnected by microwave radio or wire facilities.

A new type of radio paging system has made its appearance. This system operates in the 50–200-kc band using a loop-antenna system. A carrier-current transmitter adapted for voice modulation and transmission of audio tones for selective signaling is used. The receiving unit includes a selective device to produce an audible tone when the right code is transmitted.

Newly designed radio equipments also include a compact single side-band suppressed carrier transmitter–receiver (60 watts peak power) for operation in the 3–15-mc band, as well as a 3-band battery- or line-operated portable direction finder for the marine, broadcast, and beacon bands between 200 and 3,400 kc. A newly developed 8-channel time-division multiplex equipment has recently been placed in service on two long-distance high-frequency radio circuits.

In the field of radio navigation for aircraft, the outstanding event of the year was the declassification of the tactical-air-navigation (TACAN) system by the military services. This system, which has been under development since 1947, provides an aircraft with its distance and bearing to a ground beacon with an accuracy of 0.2 mile and 0.25 degree up to distances of 200 nautical miles. Crystal-controlled channels, 126 in number, are provided in the 960–1,215-mc band. The principle employed is that of a constant-duty-cycle distance-measuring-equipment (DME) pulse transponder with a superimposed rotating amplitude modulation. Thus, distance and bearing are provided on the same channel.

TELEGRAPH SYSTEMS

A NEW CODE CONVERTER was put into limited service trial allowing interconnection of start–stop printing-telegraph stations in the American TWX system with European stations in the TELEX system. This takes care of code and speed differences.

A transistorized radio-teletype converter was developed by the Signal Corps and the Western Union Telegraph Company to transform received frequency-shift radio signals into d-c form. Also for the Signal Corps, a "signal normalizer" was produced in which signals received on a time-division multiplex channel are regenerated and restored to the normal start–stop teleprinter cadence, avoiding added or dropped characters in operation over radio circuits. Another Western Union military development, representing a new step in transistor application, resulted in a transmitter–distributor having a tape-sensing device, with all of the conventional electromechanical components except a tape-stepping solenoid replaced by transistors.

Collins Radio announced development of a "predicted-wave" detection system. It is said that this gives a 9-db improvement over conventional radio frequency-shift systems and allows 40 synchronous 100-word-per-minute teleprinter channels within a voice-frequency band.

Development work by the Bell System is nearing completion on a fully automatic teletypewriter switching system for military use. Capable of employing line speeds of 60, 75, and 100 words a minute, this system will deliver a message in military form from origin to destination within minutes. Another development now going into service is a remote station-control system utilizing the stuntbox of the model *28* teletypewriter.

Several manufacturers introduced new and improved models of facsimile equipment, including a fully automatic 3-speed recorder for the U.S. Navy. Conveniently adjustable delay and amplitude-distortion corrective networks were developed for facsimile and high-speed data transmission circuits.

TELEVISION AND AURAL BROADCASTING

COLOR TELEVISION BROADCASTING ACTIVITY continued to grow rapidly throughout the year. Near the end of the

This fully automatic continuous facsimile unit records weather maps and other data up to 18.8 inches wide on dry electrosensitive paper. It operates at 30, 60, or 120 scans per minute, and is especially designed for the conditions of military usage

year more than 20 stations were equipped to originate live color. Approximately 65 stations were set up to originate color film and slides, and about 300 of the 364 network stations in 241 cities were equipped to transmit network color. Network color programming increased by approximately 400 per cent over that produced in 1954. Twenty-one-inch color receivers replaced the 15-inch tube of 1954, and several new manufacturers entered the field. Simplified color receivers were produced and offered at a reduced price over the sale price of 1954.

Educational television continued to expand. October 25th, 1955, found 21 stations in operation with 8 additional stations in the process of construction. Thirty-four construction permits had been granted by the Federal Communications Commission (FCC), with 16 additional applications on file.

The universities and colleges took the lead in the use of closed-circuit television, while a few high schools had installed closed-circuit facilities. A number of medical and dental colleges installed closed-circuit television and its value now has been enhanced by the development of the *3-V* color pickup camera and the color electron microscope. Closed-circuit television was also installed by the military.

In the field of standard broadcasting, new film and tape facilities have been devised to increase operational efficiency. Such equipment can provide the broadcast station with complete automatic operation over the major portions of the broadcast day. The programs, recorded on tape, are automatically placed between station breaks and commercial announcements by an auxiliary automatic control system working in conjunction with the tape recorder.

COMMUNICATION THEORY

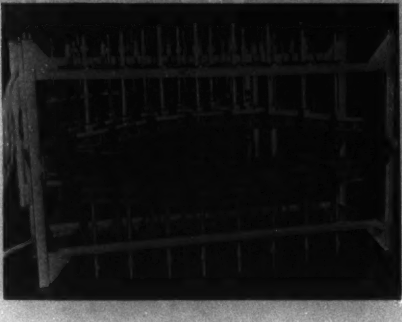
Continued keen interest in communication theory is evident; applications ranging from the design of optimum filter circuits for detection to the design of information-retrieval systems and language-translation systems have been reported. Recently, a new theorem appeared which sets forth more clearly the meaning of channel capacity and theoretical limits on transmission rate for noisy channels. Some results were obtained regarding limits on transmission rate for discrete noisy channels, when the encoding delay is fixed. Finally, several new error detecting and correcting schemes have been advanced, which represent important steps in bridging the gap between what is theoretically possible and what is feasible in a practical system.

General Applications

DOMESTIC AND COMMERCIAL APPLICATIONS

Supplemental electric heating units complete with controls are being marketed and installed for use in conventional domestic forced-air fuel-fired furnaces. These are relatively inexpensive units which are designed to be used during the mild spring and fall seasons to relieve the regular furnace of operation when it is most likely to be comparatively inefficient.

An interesting commercial electric-heating installation has been made in Tennessee which employs two electric boilers rated 450 kw and 300 kw, respectively. These boilers operate at a pressure of 250 pounds and the system includes a steam accumulator consisting of two 48-inch by 18-foot drums. The accumulator is designed to carry the heating load of the building for 2 hours out of each day during the peak-load period of the local electrical utility system. The boiler operation is controlled by a time switch.



This pilot installation is being used to conduct thermal-barrier tests on aircraft structures. The units employ clear quartz 1,000-watt lamps and can be adjusted to fit various aerodynamic contours. Similar installations have achieved up to 550 watts per square inch on short-cycle operation

The trend toward a trouble-free hermetically sealed heat-pump unit, which was reported last year, is continuing. Substantial progress has been made in increased reliability and efficiency. Experimental work is continuing on the use of small heat pumps in the $1^1/_2$-2-hp range to be used as a base heat source with the cold peaks being taken care of by conventional heating sources.

Interest in built-in domestic appliances has continued and more appliance manufacturers have entered the field. Some companies are now offering complete kitchens. There has been a growing interest in the use of color, with a greater variety of appliances now being offered in a choice of several colors.

PRODUCTION AND APPLICATION OF LIGHT

Tremendous increases in the manufacture and application of artificial light sources continue unabated. The use of man-made light, measured in lumen hours, has tripled during the past 10 years.

The big sized 200-watt *PS-30* incandescent lamp felt the influence of the trend toward smaller bulb sizes. A coiled-coil filament is placed in an *A-25* bulb, over 1 inch shorter in length, and the result is a 3-per-cent increase in light, while base heating is decreased by the insertion of a heat-reflecting aluminum disk between the base and the filament.

A new lamp color was developed for the home, a pastel pink which filters out the cooler colors of the spectrum and plays up the warmer hues. The new color is also finding acceptance in commercial applications such as restaurants, hotels, and reception rooms.

(*Continued on page 18*)

1955 Engineering Developments

A Photographic Record of Some of the Important Electrical Engineering Achievements of the Year

(Top) First commercial atomic-electric power for use in homes and industries was generated on July 18, 1955, by the General Electric Company in a building adjacent to this huge steel sphere at West Milton, N. Y., where prototype reactor for Navy submarine *Seawolf* is being tested. (Left) Submarine hull section and water tank are shown inside steel sphere. (Above) History's first "atomic picture," taken by a flash camera synchronized electrically with the first commercial atomic-electric power, catches Lewis L. Strauss, chairman of the Atomic Energy Commission, closing the giant switch that sent atomic power surging through the lines, which ordinarily conduct electric power.

▲ Use of atomic radiation to analyze chemical process streams was developed by General Electric at the Hanford plutonium plant. The device pictured measures radiation from a waste stream automatically, using spools of aluminum tape.

▲ The first major equipment for the 5,000-kw experimental boiling-water reactor plant was just shipped by the Allis-Chalmers Manufacturing Company to the Argonne National Laboratory near Lemont, Ill. Aluminum tubes are used in this 5,300-square-foot surface condenser. Double tube sheets prevent mixing of the circulating water from the cooling tower with nonradioactive water in the primary cycle. Special gas tests have been made as a precaution against leakage.

▲ Injection apparatus for electron analogue, used to test design of alternating gradient synchrotron at Brookhaven National Laboratory, Upton, N. Y. (Right) Electron analogue for studying the operating characteristics and design of the 25-bev strong focusing proton synchrotron which Brookhaven is designing, developing, and constructing. The electrons are injected into the analogue by a 1 mev Van de Graaff (not shown) and are then accelerated to energies up to 10 mev in the analogue ring, which is 45 feet in diameter. The final 25-bev proton machine will have an over-all diameter of about 850 feet.

▲ Speech waves sent out by the Signal Corps' voice-run radio are studied on oscilloscope by George Bryan, designer of the experimental device. The voice's natural energy alone provides all the power needed to run the radio, with no battery or commercial power utilized.

▲ Bell Telephone Laboratories engineers make final tests on a solar battery which is now furnishing power directly to a rural telephone line. The Bell solar battery is the first successful device to convert the sun's energy directly and efficiently into substantial amounts of electricity.

▲ A new portable telephone system designed by Bell Telephone Laboratories for the U. S. Army Signal Corps can handle four conversations at a time over a single cable. The repeater shown here is used to amplify the conversations, which may be transmitted over a distance of 100 miles.

Communication

▲ Electronic aids developed by Federal Telecommunication Laboratories for the U. S. Navy are shown in use aboard the supercarrier *USS Forrestal.* Circle on mast marks TACAN radio beacon, an integral part of the tactical air navigation system adopted by the Navy and Air Force to pinpoint position of aircraft relative to a fixed radio beacon. Circle on deck corner indicates antenna location of new UHF radio system which provides dependable 360-degree radio communication between carrier and aircraft. (Above left) The *AS-668/SR* antenna forms part of the radio system for providing long-range voice communication with carrier-based aircraft. The *Forrestal* and *Saratoga* each use eight antennas to obtain solid coverage in both the horizontal and vertical planes. The antenna array consists of three vertically polarized dipoles mounted in front of a 60-degree wedge reflector to obtain about 6 db gain over a 180-degree sector.

Courtesy International Telephone and Telegraph Corp.

◀ Over-the-horizon tests on 800 mc were conducted continuously for six months between Homestead, Fla., and sites near Havana, Cuba, a distance of about 180 miles. As a result of these successful tests, a multichannel common carrier link will be constructed for service during 1956. Shown here atop building of Federal Telecommunication Laboratories in Nutley, N. J. are diversity antennas used in multichannel over-the-horizon communication with field station in Southampton, N. Y., 91 miles away.

Aviation

◀ This portable electronic aircraft detector was developed by the Rome Air Development Center, Rome, N. Y., for possible use by the Ground Observer Corps. It is used to pick up high frequency impulses radiated by air-borne radars of possible enemy planes. Designed for poor visibility use, the detector is mounted on a hard plastic helmet and is slightly over 20 ounces. (Right) Mobile air-traffic control unit used at air fields in remote areas of the world was developed by Rome Air Development Center in conjunction with Craig Systems, Inc., Danvers, Mass. Known as "Project Two Wheels," the readily erected communications-navigation facility consists of seven small trailer-mounted light shelters easily transported in a *C-47* or towed by jeep.

◀ Convair-Fort Worth and the Cannon Electric Company have developed environment-proof, all-purpose aircraft electrical connectors. The contacts are rated 20 amperes, 500 volts to 75,000 feet at 300-F ambient. (Below left) Convair-Fort Worth and Burndy Engineering Company have designed a fast-blow fuse series usable in 300-F ambients with no exposed contacts. The mated fuse and holder have the same mounting size as *AN* circuit breakers. The blown fuse shown in the center has visible and tangible indicator.

▲ Field mobility of new Sperry control system for pilotless jet fighter-bombers is shown during U. S. Air Force acceptance trials witnessed by Air Force and Air Research and Development Command personnel at the Sperry Gyroscope Company's Flight Research Center, MacArthur Field, Long Island, N. Y. A light truck or trailer positions the compact command guidance antennas and other gear, which transmit exact split-second signals from ground "beeper" control box at lower right. (Left) Both the Southern California Cooperative wind tunnel and its capabilities were "stretched" when the old tunnel was cut in half, separated, and two new 20,000-hp Westinghouse Electric Corporation drive motors inserted inside it. The original 12,000-hp drive now serves as a starting power supply, and as a variable-frequency drive supply for the motors at low horsepower. The new 40,000-hp drive makes an air speed of mach 1.80 possible in the $8\frac{1}{2}$- by $11\frac{1}{4}$-foot test section. The tunnel is operated for the sponsoring companies by the California Institute of Technology.

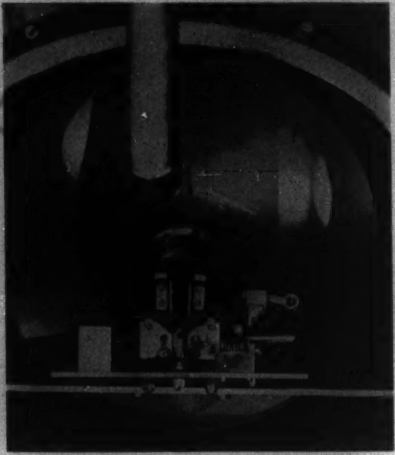
Instruments

◀ On a patient's chest is a sensitive pickup which enables physicians to "see" inaudible heart sounds, using an Electro Stethograph, developed co-operatively by Dr. D. Groom of the Medical College of South Carolina and General Motors Research Laboratories. Dr. Groom watches the heart patterns on an oscilloscope, while J. J. Bidwell of GM Research Laboratories watches them traced in pen and ink on a direct writing device.

▲ The new General Radio Company Type *1603-A* Z-Y Bridge is unique in that it can be balanced for any impedance connected to its terminals, short to open circuit, real or imaginary, positive or negative.

◀ Radio link telemetry for shaft torque measurement has been developed in the General Electric Company's General Engineering Laboratory. Strain data are transmitted from the rotating shift by means of an electronic device called a radio-link strain telemeter. Both steady-state and transient torque magnitudes may be calculated from telemetered torsional strains. The radio link telemeter is well suited to marine shafting, steel mill drives, and motor-generator combinations such as the one shown.

▲ This 3-channel dynamic tester error recorder was designed at the U. S. Naval Ordnance Laboratory, Silver Spring, Md., to check the performance of fire-control computers. (Left) A mechanically simple, relatively noise-free, high-speed electrical switch capable of producing 10,000 contact closures per second has been developed at the Battelle Memorial Institute for the Evans Signal Laboratory of the U. S. Army Signal Corps.

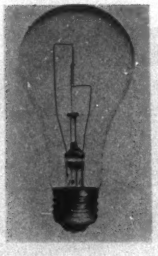


▶ Compact low-wattage mercury lamps now available from Westinghouse in ratings of 100, 175, and 200 watts will be for residential street lighting, but are also applicable industrially and commercially. Larger mercury lamps, advantages such as high efficiency, long life, and high light output are also characteristic of these lamps, available in regular mercury and fluorescent-mercury types.

Lighting

(Right and upper left) An experimental a-c carbon arc searchlight has been developed under contract for the U. S. Army Corps of Engineers by Genarco, Inc. The unit consumes 1.2 kw at 20.5 volts and will operate at 50, 60, or 400 cycles. The brightness of the arc crater is 250 candles per square millimeter, producing 10×10^6 peak beam candlepower using an 18-inch diameter mirror with a focal length of 6 inches. The unit operates unattended for 10 hours with a 30-second interruption each two hours for automatic loading.

▲ Ascending helicopter, its rotor tips lit by new high intensity identification lamps, traces an unusual pattern in this time exposure. Midway in the ascent, a flash bulb was used to "freeze" the helicopter in its climb. New blade-tip lamps, capable of withstanding centrifugal forces of 1,000 g, were developed jointly by the Westinghouse lamp division and Kaman Aircraft Corporation. Kaman devised helicopter lighting identification system under contract with the U. S. Navy Bureau of Aeronautics.

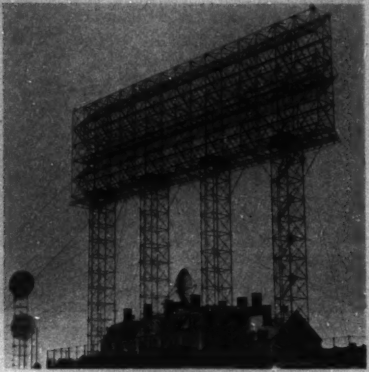


▲ A change in incandescent lamp construction by General Electric Company has resulted in improved performance. The coiled-coil filament is mounted lengthwise instead of crosswise in the bulb, producing 6 per cent more light over the life of the bulb.

▶ The "Paradome," manufactured by the Holophane Company, Inc., represents a close approach to desirable natural lighting. The shape of the lower dome assures visual comfort and low brightness, as the effect is that of tilting a lens away from the viewer.

Radio

◀ Rear view of new 60-foot experimental antenna, largest in the world for super high frequencies, which can pick up television and telephone signals sent directly through space for 200 miles. Signals are sent over the horizon in a transmission technique developed by Bell Telephone Laboratories and the Massachusetts Institute of Technology.



▲ Rectangular and 20-foot dish antenna installations at South Dartmouth, Mass., built by Lincoln Laboratories under a Massachusetts Institute of Technology contract with the armed forces. Bell Telephone Laboratories and MIT scientists collaborated in the development of scatter transmission.

Courtesy Goodyear Aircraft Corporation

◀ New link in radar network guarding North America is U. S. Navy *ZPG-2W* radar picket blimp carrying extremely high power airborne search radar produced by the General Electric Company at its Light Military Equipment Department, Utica, N. Y. Radome beneath cabin houses the radar antenna; associated electronic equipment is carried inside cabin. By carrying the radar several thousand feet in the air, the blimp can detect low-flying planes over the horizon long before surface radar equipment can.

▲ The National Bureau of Standards has developed the electronic and meteorological equipment of this boat weather station for the U. S. Navy Bureau of Aeronautics. The boat is designed so that it can be left unattended for six months. It will automatically transmit, over a 600-mile range, information about temperature, pressure, and wind speed and direction.

▲ An 18-foot paraboloidal reflector antenna for microwave research has been erected above the Western Union main radio laboratories at the company's headquarters in New York. The antenna is mounted on a 25-foot steel tower and track for rotation through 360 degrees in azimuth to cover the entire horizon.

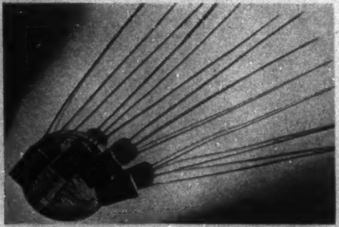
▲ The tiny device shown is one of Bell Telephone Laboratories' new silicon power rectifiers. Lined up are seven selenium rectifiers such as might be used in a television set or a private telephone switchboard. The one long-life silicon rectifier, which can operate at high temperatures, does the job of the seven others shown. The active element is a silicon wafer smaller than the head of a pin.

▶ Sound comes from both front and back of new portable transistorized radio made by the Raytheon Manufacturing Company. While the radio has only one speaker, located in the front of the set, the rear grille permits greater volume and tone. The Raytheon portable operates for a year on the power from four standard flashlight batteries.

Miniaturization

▲ An improved miniature lightweight emergency radio which permits a stranded airman to direct his own rescue has been developed by the Air Research and Development Command, Baltimore, Md. The new transmitter-receiver weighs only 15 ounces and has a volume of 20 cubic inches.

▶ J. E. Beggs, General Electric scientist, holds in his right hand a microminiature ceramic tube developed by him and associates. The *6BY4*, first commercial model, promises reduced "snow" and noise in fringe areas when used in UHF television sets. The tube is a descendant of the "lighthouse" tube in his left hand. (Inset) Enlargement of tube.



▲ The transistors shown were manufactured by the Raytheon Manufacturing Company, Newton, Mass., and are the smallest commercially available transistors. They are one quarter to one third the size of similar components developed previously.

▶ New, high-frequency transistors were first made at the General Electric Research Laboratory with equipment shown here, developed by Dr. R. N. Hall (left), who devised a method of growing the tiny crystal "hearts" of transistors from thin wires of silicon. At right is General Electric scientist R. I. Scace. Hall's "melt-back" process transistors can be used in television, radar, short-wave radio, and other electronic items where high frequency needs have called for more bulky vacuum tubes.

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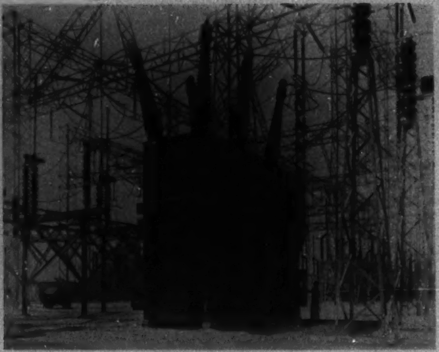
Power

▲ This "Co-operator," a new type of circuit breaker closing device which uses liquid carbon dioxide as the source of closing power has been announced by the General Electric Company's Medium Voltage Switchgear Department at Philadelphia, Pa.



▲ This 400,000-kva autotransformer is installed and operating at the Tanners Creek plant of the Indiana and Michigan Electric Company at Lawrenceburg, Ind. It and an identical unit built by Westinghouse Electric Corporation have voltage ratings of 341 to 327 kv, with taps for 318, 309, and 300 kv. There is a 13.8-kv tertiary winding for third harmonics and neutral stabilization. Power is supplied by integrally-mounted transformers.

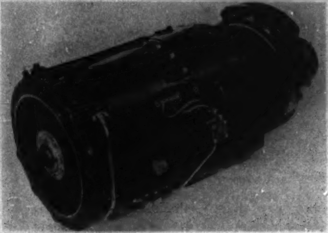
▲ First American-made 345-kv transformer has been built by Allis-Chalmers. The autotransformer, rated 120,000/160,000/200,000 kva, class OA/FA/FA, high voltage 345 kv, low voltage 230 kv, is the first of six to be installed in one of two 600,000-kva banks.

◀ Built by Westinghouse, the first 69-kv substation designed with phase-isolated leads for an impulse-voltage rating of 350 kv has been placed in operation at Penn substation of Philadelphia Electric Company. (Right) A 5,000 kw railway-mounted gas turbine power plant, built by Westinghouse for the U. S. Army Corps of Engineers, shown at its test site, Fort Meade, Md., is adaptable to foreign railway gauges and is designed to give a wide range of distribution voltages at 50 and 60 cycles.

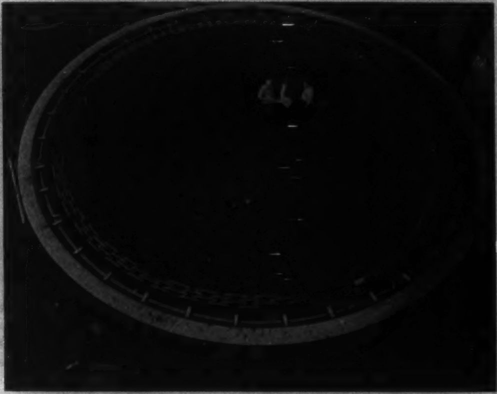
◀ E. B. Rietz and K. T. Ashdown of General Electric's High Voltage Switchgear Department inspect 10,000-ampere aluminum bus sections for the 260,000-kva conductor-cooled generator to be installed at the Eastlake power station of the Cleveland Electric Illuminating Company. (Right) Low-voltage switchgear designed by Allis-Chalmers for new 600-volt ac, 25,000 and 50,000-ampere circuit breakers includes reversible panels which permit the doors to be closed with breakers in the connected, test, or disconnected position, and a pantograph mechanism providing positive breaker positioning and ease of inspection.

Rotating Machinery

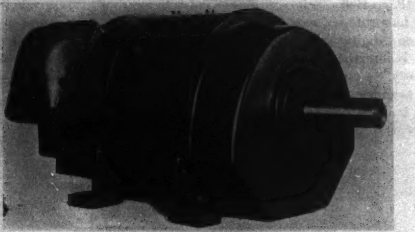
◀ The Jack and Heintz model *31,282* a-c generator is the first air-cooled machine capable of operation at sea-level ambient temperatures as high as 120 C, the new military class-C requirement.



▲ The Jack and Heintz *G190* consists of a constant-speed drive and an a-c generator delivering 40 kva, 400 cps, 120/208 volts, 0.75 power factor, with 2,000 to 8,000 rpm supplied at the input to the constant-speed drive.



▲ World's largest motor and pump turbine were built by Allis-Chalmers Manufacturing Company for Hiwassee Dam in North Carolina. The 34-foot diameter, 8-foot high stator, weighing over 160 tons, was shipped in 3 sections. The motor is rated 102,000 hp, 106 rpm. When operating as a generator, it will supply 70,000 kva at 138 kv to the system.



◀ The "Super 'T'," a new d-c motor developed by Reliance Electric and Engineering Company, features "dynamic response," a new concept of response brought forth to meet industry's growing demand for automation. Design features a low armature inertia (WR^2) plus high torque-to-WR^2 ratio.

▲ International Harvester Company tractor equipped with General Electric Company generator provides transportable source of electric power for the farm.

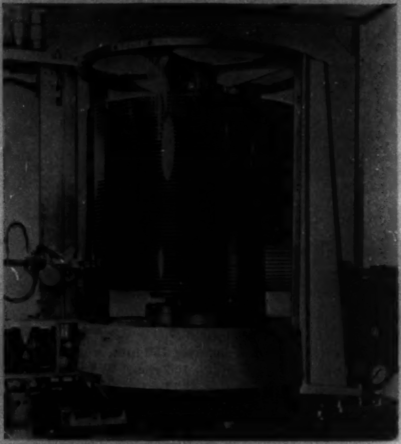
▶ These windings will generate 250,000 kw at 24,000 volts, both record highs in the United States. The high power is made possible by innercooling of the windings. These high voltage stator coils are insulated with "Thermalastic" insulation. This is one of two 250,000-kw, 3,600-rpm generating units built by Westinghouse Electric Corporation now being installed at the Tennessee Valley Authority's Gallatin station.

Official U. S. Navy photograph

◀ The NAREC (Naval Research Laboratory Electronic Digital Computer) was put into operation on a regular computational schedule during 1955, solving a wide variety of problems which arise in the scientific work of the Laboratory.

Official U. S. Air Force photograph

▲ The Monrobot, new digital computer incorporating an automatic detecting system, was developed by the Rome Air Development Center under contract with the Monroe Calculating Machine Company



Courtesy International Business Machines Corporation

▲ The new IBM 305 magnetic disk "memory" device for the storage of business information employs the random access principle of storing data and the "in-line" method of accounting. The device, with associated punched-card and tape equipment, will process each transaction as it occurs.

▶One of nearly 800 transistors used in TRADIC, Bell Telephone Laboratories' new airborne digital computer, is inserted into a "memory" package. The memory package shown is about twice the size of the production model.

▲ The "transmission penalty factor" computer, a giant new analogue computer, facilitates calculations of the most economical means of generating and transmitting electric power through nearly 8,400 miles of high-voltage transmission lines. Designed by the General Electric Company and the American Gas and Electric System, the computer is now in service at the "nerve center" of the latter company in Columbus, Ohio. It is expected to save AGE up to $100,000 a year by instant computation of power losses between points of generation and use.

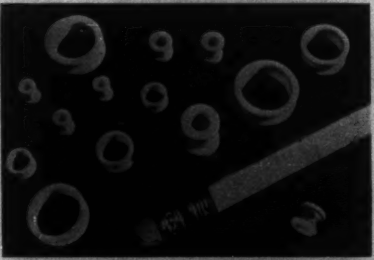
▲ ADICOR (analogue-to-digital converter and recorder) has been developed at the U. S. Naval Ordnance Laboratory. It simultaneously samples up to 9 variables, 100 times a minute, and converts these into digital numbers which are punched into IBM cards.

Computers

Courtesy International Business Machines Corporation

▲ The IBM Type *858* Cardatype accounting machine will produce simultaneously up to four different sets of documents, tags, or forms from a single typing. The Cardatype's units are (left to right): two unattended electric typewriters; Cardatype control console and card reader with auxiliary numerical keyboard on top; transmitting electric typewriter.

▲ The COMAR-1 (for computer, aerial reconnaissance), a 550-pound, 24-cubic-foot electronic computer has been developed by the International Business Machines Corporation for the Air Research and Development Command's Wright Air Development Center. It will be used primarily for speeding up reconnaissance data computation for bombing missions.



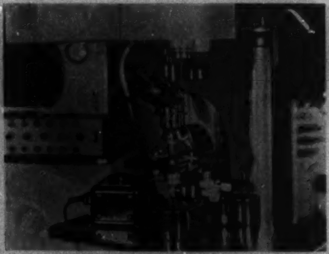
▶ Several thousand magnetic cores such as these built by the Westinghouse transformer division may be used in a single computer or data-processing machine. The cores are also applicable to high-frequency magnetic amplifier circuits, where high gain is needed.

(Above left) Magnetic drums approximately the size of small oil drums serve as temporary information "files" for the electronic bookkeeper ERMA (for electronic recording machine accounting), which is capable of servicing a total of 50,000 accounts. The drums are coated with very small iron-oxide particles, the polarity of which can be controlled by magnetic fields. The surface of each drum is divided into 300 parallel tracks on which up to 300,000 separate numbers can be stored by using the magnetic characteristics of the iron-oxide coating. (Above right) A traveler's check scanner has been developed to perfect a method of direct reading of Arabic numerals, and eventually will be incorporated into later models. The electronic bookkeeper is a development of the Stanford Research Institute, located in Menlo Park, Calif.

Research

▲D. A. Cusano of General Electric, creator of direct light amplifying phosphor, demonstrates device using ordinary slide projector. Dim ultraviolet image projected on 4-inch experimental screen is brightened by current from dry cells creating electric field across phosphor surface. Since amplification is nearly proportional, over-all contrast of projected image is unchanged as brightening occurs.

▶ Dr. J. R. Zacharias director of the Laboratory for Nuclear Science at MIT, with equipment used in developing the cesium atomic frequency standard, the fantastically accurate "atomic" clock.



▲▲A color television-microscopy system, developed by the General Electric Company, can magnify microscopic specimens, live or dead, up to 50,000 times.

▲ Automatic zone melter constructed at the National Bureau of Standards. This simple device is used to obtain extremely high purity in semiconductors.

▲ Dr. H. Horn, General Electric Company physical chemist, demonstrates the "zone melting process" for production of high purity silicon. This method of refining consists of successive recrystallizations of silicon as an ingot is slowly drawn through a gas-filled quartz tube. Induction coils wrapped around the tube cause the slowly moving ingot to melt in narrow zones.

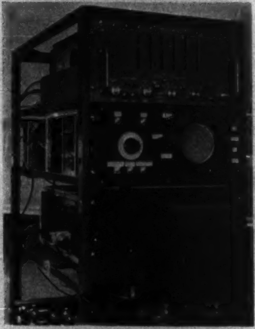
▲ Among compatible components developed by the National Bureau of Standards under the MDE-MPE (Modular Design of Electronics–Mechanized Production of Electronics) program is the adhesive tape capacitor. One element is shown being printed on an MDE-MPE wafer. Capacitor or resistor units may be printed on either or both sides, as circuits require.

Courtesy Bell Telephone Laboratories

◀ Engineer tests transmission through long-distance wave guides at Holmdel, N. J. Flexible hollow tube provides a new way of transmitting television and phone conversations over long distances.

▶ To measure residual stresses in plastics, engineers embed a stainless-steel tube containing minute-grid strain gauges in the plastic during pouring. Most of the stresses are transferred to the strain gauge as a change in resistance of the wire, permitting the amount and direction of residual stresses to be calculated.

Courtesy Westinghouse Electric Corporation



Courtesy U. S. Army

◀ A prototype of an automatic colony counter developed by scientists of the U. S. Army Chemical Corps at Camp Detrick, Frederick, Md., and DuMont Laboratories, Inc., Clifton, N. J., electronically counts in one second the number of colonies of bacteria grown in a Petri dish. The counter is expected to speed laboratory operations in bacterial colony-counting techniques manyfold and open a new area in this field. (Right) The Atlantic Refining Company has installed a million-volt General Electric electron beam generator for research in improved fuels.

Courtesy General Electric Company

Courtesy U. S. Army

▲ The Aerosoloscope, an electronic device that automatically counts airborne germs, dust, or moisture particles was developed by Chemical Corps scientists and Armour Research Laboratories, Chicago, Ill. It is based upon one with the same physical principles as developed independently by Professor Frank T. Gucker, Jr., University of Indiana.

▲ The Industrial Image Amplifier, tentatively named X-Icon, developed by the General Electric Company, puts on a special high-detail television screen the fluoroscopic image of industrial products at a brightness more than 10,000 times greater than that on the conventional fluoroscopic screen.

(*Continued from page 3*)

Shown here is a comparison of the old and new 400-watt mercury-lamp construction. On the right is the new arc-tube mount structure, which intercepts less light and is silver plated to reflect the maximum amount of light

For television studios, silica white lamps in the 750-, 1,000-, and 1,500-watt *PS-52* bulbs were developed. Fresnel lighting units were permitted greater flexibility in mounting by the new 500- and 750-watt *T-20* hard-glass lamp that can be operated in any position from "base down" to "horizontal."

In the field of reflector lamps, the 1,000-watt *R-52* and *R-57* were developed for high-bay industrial plants. The *PAR* lamp family was expanded to include a 300-watt *PAR 56* flood and a spot, a medium flood, and a flood in the 500-watt *PAR 64* size.

Improvements were made in fluorescent lamps, especially the *96T12* high-output rapid-start lamp now available in the deluxe colors. A new 40-watt starter was developed for the preheat lamp to reduce lamp mortality of the lead lamp. Redesigned core and coil structures of rapid-start fluorescent-lamp ballasts have resulted in considerable savings in material and a reduction in case size. The industry has recognized the need and value of certified *CBM* ballasts if fluorescent lamps are to function properly. Simplified dimming circuits for preheat and rapid-start lamps were developed, as well as a circuit for flashing 40-watt rapid-start lamps.

Infrared lamps made of tubular quartz in the 2,500- and 5,000-watt sizes were developed for use on high-voltage circuits for industrial heating, drying, and baking.

The family of mercury lamps has continued to grow with the development of the 100- and 175-watt lamps for use on series street-lighting circuits. Weather-duty mercury lamps were made available, the outer bulbs being made of hard tough glass to give complete freedom from glass troubles resulting from thermal shock and weathering. Lumen ratings were also increased.

A new 300-million-candlepower short-arc mercury searchlight for airport use was developed, while a redesigned 1,000-watt mercury xenon lamp is now used for Navy searchlights.

The lighting trend in the industrial field was toward the use of more fixtures with a 25-per-cent upward component of light, as well as higher levels of illumination.

Commercial fixtures, both recessed and exposed, continue to be wider and shallower. Area lighting, in large and small modules, as well as standard fixtures, veered away from large open louvers to small louvers or closed diffusing bottoms, most of them fabricated from plastic.

Because of their higher efficiency, fluorescent and mercury illumination continue to be preferred for highways, parking fields, and other outdoor applications.

Industry

ELECTRIC WELDING

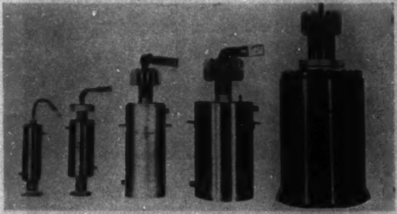
A GREAT DEAL OF WORK by several companies in the field has been done on the use of carbon dioxide as a shielding gas for welding mild steels rather than the comparatively expensive inert gases, and during 1955 this process has been adopted in many applications. Formerly gas shielding had been uneconomical compared to the flux-shielded process for welding mild steel. Now the door is open for a rather wide expansion of gas-shielded welding of steel and it is anticipated that there will be a rapid increase in the use of this process. Simultaneously there has been developed by several manufacturers a rectifier welder power source for such welding of a low-regulation type as contrasted to the usual high-regulation or conventional arc welder. Welding-arc stability is obtained by the inherent stabilizing action of high current density and rapid burn-off rate of the wire used in this process. As a result, the power supply for such welding can be obtained with substantially higher power factor and electrical efficiency than was obtainable formerly with either conventional rectifier welders or motor-generator welders.

INDUSTRIAL POWER RECTIFIERS

A NEW AND LARGER SEALED IGNITRON TUBE rated at 1,000 amperes, 250 volts has been announced. This larger tube makes possible the application of sealed ignitrons for industrial ratings up to 1,500 kw, 250 volts, on 6 tubes. This sealed tube permits the application of sealed rectifiers to a much wider range of ratings than was possible previously.

Pumpless mercury-arc rectifiers are being applied in heavy-duty electrochemical service for large aluminum-reduction plants in the United States and Canada. In one U.S. installation, two pot lines, each rated 72,000 amperes, 750 volts, will be supplied by 12-anode pumpless ignitron rectifiers.

A notable application of a fleet of ten 4,000-hp 6-axle



Series of available sealed ignitron tubes, rated 100, 200, 400, 667, and new-design 1,000 amperes, respectively

Stand 5 operators control cabinet on tandem cold-reduction mill equipped with automatic gauge control

174-ton rectifier locomotives has been made by the New York, New Haven and Hartford Railroad. These are designed for operation at 11,000 volts, 25 cycles. Confidence in this type of motive power is shown by an order placed by the Virginian Railway for twelve 3,300-hp 193-ton rectifier locomotives.

A small reversing hot mill driven by a 630-hp 925-rpm 550-volt d-c motor equipped with an electronic d-c motor drive has been placed in operation. The rectifier drive provides rapid-reversing maximum torque at low speeds, and wide operating speed range.

MINING AND METALS INDUSTRY

Metals Industry. This year drive systems for the metals industry became bigger, faster, more automatic, and greater in number. The higher speeds, larger machinery, and larger production require increased automation and greater precision in the automatic process control.

Automatic gauge control systems were placed in operation on high-speed tandem tinplate cold-reduction mills. A typical installation in the Pittsburgh area utilizes two X-ray gauges and transistor–magnetic amplifier regulating equipment. The first X-ray gauge located between stands *1* and *2* provides the feedback signal necessary to operate stand *1* screwdown motors to regulate strip thickness at this point. The second X-ray gauge measures finished strip thickness out of stand *5* and provides a feedback signal to effect gauge control by varying that stand drive motor speed.

For the first time in the United States a reversing hot mill is being powered by a rectifier drive. Common in Europe, the first U. S. rectifier drive is rated up to 500 kw with peak ratings normal for blooming-mill service. Magnetic-amplifier regulating systems provide accurate control of rectifier voltage, phase retard for current zero switching of line contactors, and deceleration and acceleration of the drive during reversals.

Mining. For years illumination of producing areas in gassy coal mines was by means of storage-battery-powered cap lamps worn by the miners. With the introduction of electrically driven mining equipment, the illumination was somewhat improved by the addition of headlights mounted on the machines. However, as production was increased with newer and larger machines, it became evident that the level of illumination that had been tolerated for so long was not adequate. Experimental lighting system with fluorescent tubes in a commercial coal mine has shown the possibilities of satisfactory area lighting.

ELECTRIC HEATING

In a rapidly developing field as electric heating, there are bound to be many outstanding developments.

Induction heating for forging and other applications has made great strides by the employment of dual-frequency installations. Under such operation, standard 60-cycle energy is used in the induction heating coils for the first part of the heating cycle. High-frequency energy, 3,000 cycles or higher, then takes over and completes the heating cycle, with economies in production and equipment.

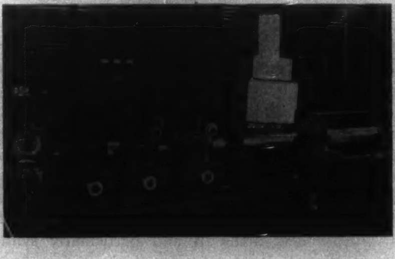
Dielectric heating has shown its versatility in the fabrication of foamed vinyl, a superior product in many respects over foam rubber.

High-frequency resistance heating has made great progress for localized hardening applications, as in the chain-saw industry and in the fabrication of welded metal tubing. In this latter operation, output per kilowatt of welding power has been increased two to threefold, and materials such as copper of 100-per-cent conductivity, formerly impractical to handle by resistance welding methods, can be processed readily. Product quality is improved and flexibility of the tube mill is greatly increased. In this method, high-frequency current, of the order of 1,500 amperes at 400,000 cycles, is introduced into the stock to be welded by means of contacts riding on the metal surface. The current, because of the proximity effect, flows on the interfaces of the metal which are subsequently forced together under pressure to form the welded seam.

Power

CARRIER CURRENT

In the past year there have been notable improvements in the power-line carrier-current apparatus available.



High-frequency resistance tube welding installation

Power-line carrier transmitter–receiver for distance relaying uses transistors throughout instead of vacuum tubes, and is compact enough to be mounted on the switchboard alongside the relays

Major reductions in channel bandwidths have been achieved with resultant conservation of the frequency spectrum. There has been announced a transmitter–receiver equipment for carrier relaying with high-selectivity filters to provide additional carrier channels without impairment of relaying speed below that required.

Transistors are becoming important circuit components leading to spectacular reductions in size of equipment and in power consumption. For instance, the high-selectivity set mentioned is available with a plug-in transistorized modulator to provide voice communication for test.

Completely transistorized carrier transmitter–receiver equipments for relaying were tested this year. These sets use no vacuum tubes whatever and, as a result, for the same performance, are much more compact, run cooler, and draw a small fraction of station battery current as compared with conventional vacuum-tube sets. This equipment is compact enough to be mounted on a switchboard beside relays and meters.

Although present experience is not sufficient to guarantee transistor life it is believed that, compared to vacuum tubes, the use of transistors will lessen maintenance problems.

There is also available new narrow-band frequency-shift equipment for telemetering and other telegraphic functions. The receiver is completely transistorized, and the transmitter uses transistors for all but the output stage with a reduction in power consumption of up to 75-percent. Only 6 watts are consumed by the receiver which operates without any perceptible generation of heat.

An interesting application of carrier current is a monitor system, which operates by a unique means of remote modulation of a carrier signal to give a fail–safe indication for transmission and distribution breakers, reclosers, and other on–off functions.

INSULATED CONDUCTORS

WORK HAS BEEN STARTED at Princeton University, Princeton, N. J., on a study of thermal resistivity of soils, which will give data of great value in rating all underground cables, and pipe cables in particular. This is a 3-year project. Other studies in progress include lightning protection of cables, nature of breakdown in cylindrical dielectrics, and sequence impedance of pipe cables.

A large amount of attention has been given to cable insulating materials and cable oils. There is a great interest in the new materials and particularly synthetic films, papers, and oils as they relate to the design of higher voltage cables for operation at 220 kv and above. As evidence of this interest, the Association of Edison Illuminating Companies has recently approved sponsorship of a $500,000 high-voltage underground-cable research project covering a research, development, and testing program involving cables in the 330- to 400-kv range. This is the result of the increasing need for bulk power lines and the difficulty of securing right-of-way for overhead lines of present voltages.

Properties of cable sheathing materials, such as lead alloys and aluminum have received attention, especially from the standpoint of providing longer cable life. Coverings for such cables as protection against corrosion are under review; studies of lower cost high-voltage systems will soon start.

Standards for cable limiters and overload damage points on various insulations used on low-voltage a-c networks are of great value. Increased attention is given to standards activities; the *Classified Bibliography on Insulated Conductors* is an example of what can be done to keep engineers abreast of published data in their field. The European Practice Subcommittee has received considerable useful information from abroad and has made much available in return.

Work is continuing on various testing methods for cables, including impulse voltage testing, tensile strength and hardness of sheaths, ionization levels for rubber, and thermoplastic insulated cables, etc.

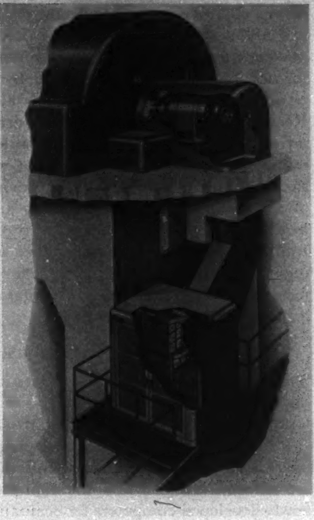
POWER GENERATION

AN EXTENSIVE STUDY is being made dealing with factors covering the performance of thrust bearings in large hydroelectric units, which is to be submitted to the industry, in the expectation that it will provide substantial assistance in eliminating a problem which has been of some concern during the years since World War II. An outstanding report on "Fire Protection for Generating Stations" is currently being reviewed.

ROTATING MACHINERY

DURING 1955, progress has been made in further developments for conductor cooling of large turbine generators by gaseous or liquid coolants. Some machines have been

The turbine end of the liquid-cooled armature winding of 260,000-kva generator, with the inlet and outlet tubes for the coolant located inside the fluted insulation boots extending radially outward from each coil



Turbine-generator excitation systems consisting of an overhung 420-cycle inductor alternator, selenium rectifier, and magnetic - amplifier control have been installed in 1955. The rectifier enclosure is below the generator floor level and is ventilated through a duct to the exciter. The inductor alternator exciter rotor has no windings. Speed of response of the system is exceptionally fast

built, combining conductor cooling in part of the machine with conventional cooling in the remainder of the machine. One such unit, rated at 90,909 kw, 0.85 power factor at 1/2-pounds-per-square-inch-gauge (psig) hydrogen pressure, having a conductor cooled rotor and a conventionally cooled stator, went into service during the year. A liquid-conductor-cooled armature type of generator having a rating of 260,000 kva has been built during 1955. A large hydrogen-conductor-cooled machine, rated at 270,588 kva, 3 phase, 60 cycle, 20 kv, 3,600 rpm, went into service during 1955.

Because of higher and higher current ratings on large modern generators, development of gas-cooled terminals has been necessary in order to keep the size of these terminals down to reasonable dimensions. In general, the cooling gas is circulated through the terminal in such a manner as to come directly in contact with the conducting metal of the terminal.

Development of exciter housings for outdoor turbine generators includes a "skin-tight" "step-in" variety with full above-deck ventilation.

An excitation system for turbine generators employing a permanent-magnet field type of shaft-driven a-c generator, with a selenium rectifier, has been built for use with a large turbine generator.

The largest capacity 3,600-rpm single-shaft turbogenerator so far produced was placed in service during 1955 at Philadelphia Electric Company Cromby Station. This is a Westinghouse Electric Corporation direct gas-cooled unit with a maximum capability of 270,588 kva, 3 phase, 60 cycle, 20 kv at 45-pounds-per-square-inch-gauge hydrogen pressure.

The demand for improved performance in the application of motors to automation has prompted the development, by one manufacturer, of a line of d-c motors having so-called dynamic response. This is accomplished with design emphasis on low armature inertia WR^2, plus a high ratio of torque to WR^2. This enables high acceleration to be obtained, and also provides for minimum speed drifting.

Development of a silicone rubber type of material, which is moisture resistant and has excellent mechanical and electrical characteristics at normal and at elevated temperatures, promises to provide an excellent insulation for motors, as well as other electric equipment.

A completely new insulation system has now been developed by the General Electric Company which is expected to increase motor life by 50 per cent. Called "Polyex," this new insulation, developed for form-wound Class-*A*-insulated induction motors, has been subjected to thorough evaluation processes, both in the laboratory and in the field. Applied to motors ranging from 100 to 3,000 hp, up to 5,000 volts, the system has characteristics unequalled in other Class *A* insulations.

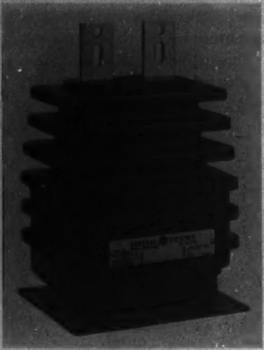
Another important development of 1955 is that of the tractor-mounted generator which is a complete self-contained power station, to be utilized in the following areas: (1) moving power—to drive motors or trailing equipment such as the hay baler; (2) transportable power—to take electricity where power lines do not go, for such items as power tools, drills, circular saws, electric chain saws, post-hole diggers, and other equipment such as cement mixers, sprayers, and welders; and (3) emergency power—to keep the house, barn, and critical auxiliaries in operation when the power lines are down.

The generator is fundamentally a $12^{1}/_{2}$-kw 208-volt 3-phase 60-cycle 3,600-rpm 4-wire revolving-field alternator, suitable for powering standard 115-volt single-phase and 220-volt 3-phase applications. It has a voltage-drop compensator, overload protection, a distribution system, and an exciter all integrally mounted. Thus, all the functions of a generating station and distribution system are contained in a single unit.

SWITCHGEAR

AMONG THE IMPROVEMENTS in circuit breakers during 1955, attention has been given to the ease of removing arc chutes of power air magnetic circuit breakers to facilitate inspection and maintenance.

Largest 3,600-rpm single-shaft turbogenerator being loaded on railroad car for shipment to power station



New current transformers extend Butyl-molded outdoor-type transformer line to 15-kv voltage class

One manufacturer reports the availability of a 13.8-kv magne-blast circuit breaker having an interrupting rating of 750 mva.

Outdoor oil circuit breakers rated 14.4 kv, 1,000 mva through 69 kv, 2,500 mva are now furnished with American Standards Association (ASA) standard-apparatus bushings, which are dimensionally interchangeable with those of many transformers.

Low-voltage air circuit breakers of the 600-volt class have been given higher interrupting ratings for applications at 480 volts and 240 volts, with corresponding design modifications.

The use of epoxy resins and polyester glass-base laminates as insulation for various components of metalclad switchgear has found wider acceptance.

The self-cooled rating of isolated phase bus has been extended to 10,000 amperes; a rating which may also be obtained with forced-air cooling, having the same physical dimensions as the 8,000-ampere self-cooled design. Isolated phase buses are now available in 138-kv class for use in metropolitan-area stations.

TRANSFORMERS

Built and shipped during 1955 were the industry's first 300,000-kva transformers, the largest regulating transformer rated 194,774 kva, and the largest 275,000-kva forced-oil water-cooled transformer.

A new load tap-changing mechanism which increases the possible capacity of regulating transformers from the former limit of about 150,000 kva to more than 400,000 kva was designed for the 194,774-kva regulating transformer. The contactor is of the double-break oil-blast type, with arcing contacts which are expected to provide in excess of 50,000 tap changes before servicing.

The design of two revolutionary gas-insulated transformers has been completed. A prototype unit has been built and tested, and construction of the units themselves nearly finished. Rated 2,000 kva, 69 kv, the transformers will utilize sulphur hexafluoride gas as a coolant and insulator.

The application of full-value switching surges to a single-phase 200,000-kva 345-kv transformer (three units form a 600,000-kva 3-phase bank), in addition to the standard ASA test, is a milestone in the progress towards making adequate tests to demonstrate the suitability of transformers for service. The test was made by applying 240-cycle power for over 4,000 microseconds at a value of 920 kv. Recent improvements in lightning arresters have made it advantageous to use lower insulation level transformers for many applications. Reduction of excessive insulation strength without some means of proving the transformers' ability to withstand switching surges is believed to have held back acceptance of these lower strength and lower cost transformers. This test is one more step in the establishment of realistic insulation levels for high-voltage transformers. The final goal is adequately protected transformers at considerably lower cost.

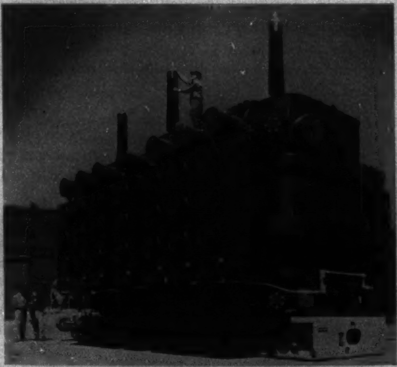
TRANSMISSION AND DISTRIBUTION

Increasing interest in the design and development of higher voltage transmission lines (330 kv and higher) has resulted in studies on radio and television interference.

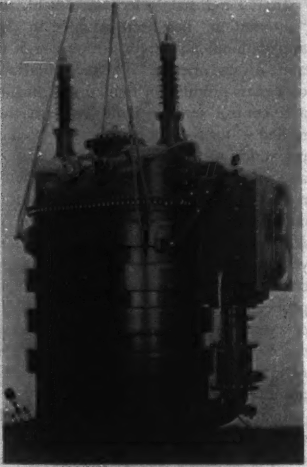
Recent advances made in analyzing incremental transmission losses have resulted in combining the forces of the a-c network analyzer and the digital computer. Several newly developed computers for evaluating these losses have been placed in operation within the past year.

The increasing utilization of heavy demand electric appliances has stimulated considerable interest, during the past year, in the use of higher voltage distribution. The high summer loads experienced by a number of utilities, who previously have not had unusual sales of air-conditioning equipment, have contributed appreciably to the interest in this field. These larger blocks of load indicate that higher voltage can be justified for secondary as well as primary distribution under some conditions.

Indications are that the shift to higher voltage in general may be slow because of high changeover costs. The present trend seems to be for use of higher primary distribution voltages in the rural areas and higher secondary voltages in the urban areas.



Power transformer, rated 300,000 kva, for Tennessee Valley Authority



Gas-filled transformer, rated 480Y/277 volts, for test only. Oblique view of completed transformer showing cooler and low-voltage side

Increased interest in the advantages which accrue when bundled conductors per phase are employed for transmission circuits has prompted an investigation of the requirements imposed on other elements of the transmission system. Efforts are being made to determine the designers approach to the strength requirements of the supporting structures. Flashover characteristics of insulators, wood and air gaps in combination, are under investigation.

Continuing research and development in power capacitor design and engineering, since the introduction of General Electric Company's 25 reactive kilovolt-ampere (kvar) power capacitor in 1942, resulted this year in the development of a 50-kvar power capacitor. Gradual but important improvements made during this 13-year period in paper dielectrics and impregnants were leading factors in making this larger reactive kilovolt-ampere design feasible. New higher capacity power capacitors will make possible more reactive kilovolt-amperes per unit of space per equipment. Equipments will have fewer bushings and wiring connections. The advantage of less weight with more compact equipments will be an important feature in pole-type installations, where bending moment is a limiting factor. In general, the 50-kvar capacitor design will aid in providing more reactive kilovolt-amperes to meet increasing kilowatt peak loads. This represents a continuation of the present trend towards using more capacitors as an important part of distribution circuits.

Science and Electronics

COMPUTING DEVICES

THE PRINCIPAL ADVANCES in computing devices during 1955 were in the field of digital computers and associated equipments. This year marked the beginning of wide use of large-scale digital computers for business applications, the use of magnetic tape for storing large files of business data, and the interconnection of data-processing systems by long-distance communication links.

Random-access memories capable of storing 5 million alphameric characters were developed using magnetic disc-recording techniques. These devices serving as file memories for business applications will permit posting each transaction as it occurs rather than accumulating data in weekly or monthly batches. Such systems provide management a continually up-to-date picture of all accounts.

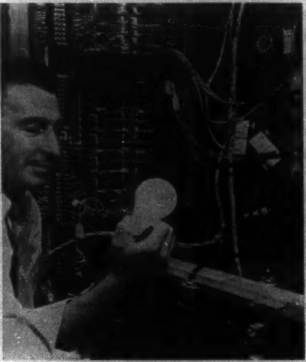
Important progress was made in utilizing solid-state techniques. Several all-transistor digital computers were constructed, one can operate flawlessly in planes flying at supersonic speeds, and many digital computers now in production utilize magnetic-core memories. Thyratron-like transistors were developed for controlling electromechanical elements of input–output equipments. Now in the research phase is a superconducting switching element, named "cryotron," which employs a magnetic field to switch a supercooled wire in and out of superconductivity.

New input–output devices were developed. Printers with output rates of 1,000 lines per minute, character-recognition machines capable of direct reading of printed data from properly prepared documents, and oscillographic output devices with and without photographic attachments are now available.

The utilization of digital computers has become more efficient by the application of automatic-programming techniques. Many compiling and interpretive routines have been prepared, which allow the computer itself to assume much of the effort required to translate problems into computer language.

One ambidextrous machine can automatically wire complex electrical apparatus; instructions are fed to the machine from a punched tape, and a series of relays, acting as the machine's "brain" translate this information into electric signals to control the cams and gears of the machine.

Analogue techniques have been applied in the development of several new special-purpose computers; e.g., an aerodynamic performance computer for use by aeronautical design engineers. Analogue computers are being used as



TRADIC, Bell Telephone Laboratories' new airborne electronic "brain," takes less power to operate than the 100-watt lamp held by engineer E. F. Allgeyer. The computer in the background contains nearly 800 transistors instead of vacuum tubes, and takes only one twentieth of the power

New technique speeds assembly of magnetic-core memories for computers by factor of 5 to 1. The ferrite cores are loaded into a molded form, fastened to a vibrating table, for wiring. The wired cores, comprising a complete plane of memory, are later removed from the form and connected to a frame; the frames can be stacked to form an array

parts of semiautomatic-control systems for large power-transmission networks to compute such quantities as "incremental cost of power delivered."

ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

The field of electrical techniques in medicine and biology continued to be an active one for developments in 1955.

This year saw the development of a practical device for making X-ray snapshots of heart action with 0.001-second exposures to improve diagnosis of heart disease. X-ray motion studies aid greatly in observing fast movements in the human body which, heretofore, were impossible to record for any length of time because of danger of excess dosages of radiation. Image intensification reduces this hazard by providing brighter images without any increase in dosage.

An improved scintillation spectrometer obtains extremely sharp localization of radioactive material in tracer studies of biological specimens and the human organism.

The application of electrical sensing and recording techniques in biophysics and medicine, as well as data processing in connection with biological problems, have made great strides.

Automatic monitoring of physiological quantities during anesthesia and surgery in operating room procedures has been developed as a valuable clinical aid.

ELECTRONICS

The year 1955 has been one of rather rapid improvement along many fronts of the electronic arts, rather than a year particularly marked by a few spectacular advances.

However, one interesting and strikingly new announcement that has come this year has been that of an electronic air-conditioning and refrigerating unit, based on the engineering use of the Peltier effect. This is the inverse employment of the technique commonly used for measurement of temperatures by means of thermocouples. Somewhat related in the solid-state area was the putting into engineering service of the solar battery, which was announced as a research item last year.

In the industrial electronics field, the use of the word "automation" has been of value in tieing together, as to applicational objectives, a number of types of progress of quite diverse origins. Thus, automation implies fabrication of a mass-production type. For mass-production welding and control service, ignitrons with thermostatically controlled water cooling have been introduced. This provides protection of the tube against failure of water supply, and also saves water by adjusting the flow of coolant to suit the needs of the service. Automation also applies to remote control, as necessary, for example, in the submarine *USS Nautilus*, which, according to announcements made this year, employs fission counter tubes, compensated ionization chamber tubes for the detection of thermal neutrons, and proportional counter tubes. Also, to be considered a part of automation is the very great progress made this year in the use of combinations of metal-plate rectifiers and magnetic amplifiers to eliminate make-and-break relays from automatic-control equipment.

It appears promising that this type of development may extend to control of the main power flow as well as auxiliary circuits. As an example, fused silicon diodes are now capable of handling many kilowatts of power at very high efficiencies in low-voltage systems, and can now operate at temperatures from −65 to +190 C. Some of the newer diodes now commercially available have voltage drops ranging down to 0.7 volt at a current of 8 amperes.

Of course, the use of electronic computers is a part of automation. A marked increase is apparent in the commercial availability of electronic computers. Their capabilities are becoming much better understood, and techniques have been developed for their use in many business-office procedures. There are now over a dozen manufacturers of these devices, and some rather simplified units are available. More specifically, a new storage tube has been introduced for use in computers, or computational aids, having a sensitive information-storing surface on the interior of a face plate scanned by an electron beam, with a signal electrode outside the plate. For digital-computer use, there have been substantial advances in the develop-

Two 5-tube radio receivers; the one on the right has been wired by ordinary soldering methods; that on the left was wired by a process for making solderless wrapped connections. Bell Telephone Laboratories has developed an ambidextrous machine, called the "M-4," that uses this process in production

An application of the fluoroscopic-screen intensifier, used in medical radiological practice, is the ability to obtain X-ray motion pictures on 17-mm film. It mounts on a diagnostic table, and the operator views the image during actual photography. The separate pedestal control contains electric circuitry for synchronization and to provide constant brightness for optimum film density

ment of a barrier grid storage tube, using a fine-mesh grid to prevent redistribution of charge. This provides substantial increase in speed of access. Also a rather striking new development in the digital-computer area has been employment of ferrite storage units having 3-dimensional arrays, as against last year's 2-dimensional arrays. This permits 3-dimensional circuit access.

As to transistors, progress has been characterized by higher outputs, wider temperature limits, use at higher frequencies, and improved manufacturing techniques. Particularly significant are improvements in quality, uniformity, long life, reliability, and lower cost. Publication of studies affecting surface conductivity, provide a much improved understanding of some aspects of transistor behavior.

However, the most marked change relative to transistors was the very substantial and widespread increase in understanding of how to apply them. Their extended employment in military, industrial, and merchandising equipment is perhaps the outstanding feature for the year. A number of radio receivers are now on the market using transistors, particularly for small portable units.

In the early days of radio, dry cells were used almost universally in radio receivers. With the coming of a-c tubes, they disappeared from the scene, but it now seems that dry cells may be coming back into the picture for general use in radio receivers, where transistors are employed. Another suggestion, as yet in the early development stage, is that it may become possible to use the carrier signal from a nearby powerful radio transmitter as a source of power for a radio set, which can then be tuned to receive remote signals.

Of importance to navigation and standard-frequency transmission is the announcement of detail studies of phase-stable transmission at 16,000 cycles per second from England to the United States. Considered for standard-frequency use, such signals exhibit Doppler variations of about 2 parts in 1 billion during sunrise and sunset periods. Diurnal variations of transmission time are of the order of 40 microseconds, and the diurnal variation is predictable to about 2 microseconds, or 10° of phase.

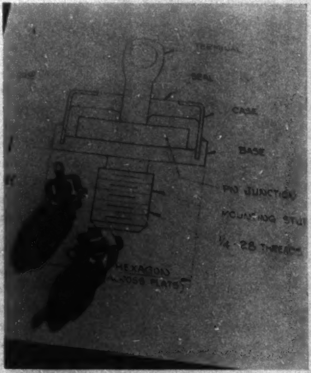
This year has seen the first significant application of pulse-code techniques to high-precision telemetering for measurements of performance of airplanes and guided missiles during flight. Related to this improvement in the quality of information obtained by telemetering is the development of new mathematical methods for studying system behavior by sampling of data, using a new type of operational calculus.

In television, there has been an important advance in the development of a suitable tube design using an all-glass bulb, providing a large picture size together with a compact and readily assembled tube. Also important has been a development in television tuning controls resulting from the introduction of a new tube used in cascade tuners; a 5 db increase in gain in tuner-amplifier efficiency, plus a significant decrease in noise figure, has been achieved.

In the fields of microwaves and millimeter waves, the constant struggle for bandwidth has rapidly pressed microwave components into the millimeter region. Thus, a new semiflexible circular waveguide construction has been announced. Operating in the TE_{01} mode at 50,000 mc, "oversized" guide can transmit bands several thousand megacycles wide with attenuation in the order of 1 to 2 db per mile. In addition to the low loss, this mode also offers power-handling advantages which are being exploited for high-definition radar applications. Considerable fundamental-development work continues in "surface wave" and "open" type waveguides which possess unique properties at these extremely short wavelengths.

Basic instrumentation units, such as signal sources, power meters, etc., have become commercially available at these extremely high frequencies and have spurred further research in a magnetic resonance phenomena on ferromagnetic ceramics (ferrites). New classes of these ferrites are being made available to expand the scope of their microwave applications. One of the valuable new instruments now commercially available is a packaged traveling-wave-tube amplifier providing 30-db gain between 2,000 and 4,000 mc, at an output power level of 1 watt.

A very interesting new microwave-actuated research and



These small fused silicon diodes offered by Westinghouse are at present available at ratings of 50, 100, 150, and 200 volts. Applications include such diverse fields as magnetic amplifiers, rotating rectifiers on the shafts of brushless generators, welders, plating lines, and power packs

magnetic instrumentation tool is the electron paramagnetic-resonance spectrometer. Fundamentally, this device measures the interaction between an applied magnetic field and the magnetic moment of unpaired electrons in matter. This technique can be used both to study the paramagnetic properties of substances, and with some modifications to measure the strength of magnetic fields. Another microwave-actuated development this year is the use of a device employing cesium atomic dipole resonance to provide a very accurate and yet portable absolute-frequency standard. As yet in the early research stage is a device or principle known by the name "maser," which is, in effect, a molecular-beam microwave amplifier that appears capable of operation at spectacularly low-noise figures at millimeter-wave frequencies.

In the microwave radar field there has been made commercially available a new pulsed magnetron for radar weather service, operating at 5,400 mc. This represents expansion of the use of microwaves into a new applicational field which may have very far-reaching eventual importance. Another research development employs field emission maintained at a constant current by a pulsed circuit arrangement. This gives promise of permitting employment of field emission sources in wave guides without the use of filaments.

In a completely different field of physical electronics, there has been developed a light amplifier, which provides "enhanced photoluminescence," described also as electroluminescence enhanced by visible-light effects.

There have been important advances in the art of magnetic recording during the past year. In particular, there is a new sprocket drive for a 35-mm magnetic film with very much reduced flutter, giving a very high uniformity of speed and a very high quality of sound reproduction. Also new is a stereophonic magnetic-tape reproducing system utilizing in-line heads for home installation. This permits emphasis on availability of stereophonic prerecorded magnetic tapes which will soon be available in ever increasing numbers. There is now also available an automatic programming system, operating from magnetic tape, which will permit over 24 hours of operation of broadcasting stations from prerecorded tapes, with prerecorded station breaks, announcements, and disc recorders from an automatic changer. This permits complete advance programming and automatic operation with any desired mixture of program content. This is an outstanding example of automation in the field of information transfer.

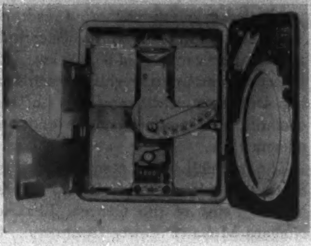
A magnetic-tape transport unit for computer in which tape movement is controlled by two pinch-roller assemblies, each of which is controlled by a high-speed moving-coil actuator. Each of the pinch rollers moves 5 to 6 thousands of an inch to press the tape against the capstan shafts. Only one of the rollers is effective during each of the forward or reverse operations. Positive action is obtained during both the engagement and release of the pinch roller assemblies by reversal of the moving-coil current

In the Magnetic Tape Data Reduction Center, General Electric Company, this equipment reduces engine operating data, recorded on test, to form for analysis and evaluation in a matter of hours instead of weeks. On the inclined panel to the left are controls for recording channels of input data; the spools hold recording tape for input to the facility. The rear wall panels provide oscillators, band-pass and tuned filters, multichannel presentation scopes, and frequency spectrum display with a panoramic analyzer

INSTRUMENTS AND MEASUREMENTS

The broad scope of instrumentation precludes any adequate coverage of progress during the year 1955. Only a few significant developments can be mentioned. Though new materials have permitted improvements in the design of many instruments, major contributions have come in the field of recording instruments. Thus, a new electronic receiver–recorder has been developed for d-c-type pickups and d-c telemetering systems used in power plants, process plants, and laboratories. The recorder may house as many as four plug-in d-c receivers or two receivers and two pneumatic controllers. Nonlinearity inherent in many pickups is extracted by a characteristics cam in the receivers. This makes it possible to combine four records from pickups having different characteristics on the same uniformly graduated circular chart.

Another device is an automatic oscillograph for use in power-transmission circuits to obtain records of unanticipated disturbances. A fast-start feature built into the automatic record paper holder enables it to start recording 0.004 second after the disturbance begins. The record will stop after a predetermined interval (1 to 6 feet of record length) or after the fault has cleared, whichever is longer. The month, day, hour, minute, and second is automatically photographed at the end of each record. This oscillograph contains the features of the general-purpose oscillo-



New electronic receiver–recorder, developed for d-c-type pickups and d-c telemetering systems, may house as many as four plug-in d-c receivers or two receivers and two pneumatic controllers

graph previously described. It may be converted into an oscillograph for general-purpose use by replacing the automatic record paper holder with the standard paper holder from the general-purpose oscillograph.

Tremendous strides have been made, as expected, in the field of nuclear instrumentation. The Atomic Energy Act of 1954 and the major effort at declassification of reactor technological information gave impetus to an enthusiastic response of industry to the challenge of producing "competitive nuclear electric power." New instrumentation for the severe corrosion and radiation conditions of water- or liquid-metal coolants is continually being perfected and has made possible reactor-power submarines and the introduction of nuclear electric power into transmission lines for distribution to homes, farms, and factories in the near future. Package control systems, high-precision reactor power calculators, and nuclear reactor simulators which synthesize operating characteristics have helped the progress in the instrumentation art. An experimental system including a neutron sensitive thermo pile feeding a second-harmonic transistor excited magnetic modulator with a tuned transistor amplifier has been developed for detecting neutron flux.

Applications of nuclear techniques in medicine and biology are exemplified by a unique eye probe, which is a counter tube with a curved mica end window, enabling the surgeon to probe behind the eyeball; also a gamma counter of high geometric efficiency, which makes it particularly suitable for measurements of extremely low levels of gamma radiation, such as that which is encountered in tracer investigations.

A small precision diaphragm-operated strain-gauge pressure transducer has been developed. The gauge can instantaneously measure varying pressures as required in supersonic wind-tunnel testing. Incorporating a Wheatstone bridge with four active arms, this pressure gauge may eliminate manometer racks with the attendant savings in space, as well as reductions in test and recording time and money; no penalty is paid in accuracy. Operation may be for absolute or differential pressures as low as 10-mm mercury absolute, to an accuracy of 0.1 per cent. In static pressure work, it features self compensation for temperature; in dynamic applications, it has freedom of phase and amplitude errors inherent in tubing connected manometers. Transducer output is a convenient d-c voltage for analogue and digital computing equipment as well as indicators.

MAGNETIC AMPLIFIERS

The almost universal acceptance of magnetic amplifiers as extremely reliable components for aircraft and missile control systems was seen in 1955. They are finding extensive application in autopilots.

Operational-type magnetic amplifiers are being used for a variety of low- and high-signal applications throughout air-borne systems. For low-signal applications, the magnetic amplifier has proved particularly adaptable to the amplification of the low potentials produced by thermocouples.

Magnetic amplifiers are used extensively in atomic-powered submarines, as evidenced by the following: "The control servos for the General Electric Company's nuclear reactor for the atomic-powered submarine employ magnetic amplifiers throughout. Magnetic amplifiers were selected because of their long service-free life and their reliability. In addition, the safety system which guards against any malfunction of the nuclear reactor and its controls is made up primarily of magnetic amplifiers."

METALLIC RECTIFIERS

During the past year considerable development work has been done to improve characteristics of the existing metallic (semiconductor) rectifiers.

Selenium rectifiers capable of withstanding temperatures up to 150 C have been developed showing life expectancies of several hundred hours, as against less than 100 hours.

Copper-oxide rectifiers using double the existing voltages per cell and with an expectation of reaching up to 26 volts have been announced.

Germanium rectifiers have been applied to apparatus in larger blocks of power. One of the largest installations in the world has a rating of 65 volts at 30,000 amperes, and is used to make hydrogen gas.

Silicon rectifiers have been developed by several manufacturers in an effort to obtain a device that will stand higher temperatures than the germanium type. Currently, individual cells rated at 140 volts and 25 amperes are being sold. Major applications will no doubt appear on the market during 1956.

The importance of metallic rectifiers has resulted in the International Electrotechnical Commission establishing a committee to develop international standards; the first meeting having been held in England in July 1955.

NUCLEONICS

Highlight of 1955 in the field of nucleonics was the ushering of atomic power from the realm of the philo-

Automatic oscillograph for use in power-transmission circuits obtains records of disturbances. Fast-start feature enables it to start recording 0.004 second after the disturbance begins

Curved mica end-window counter tube enables surgeon to probe behind eyeball

sophical and conjectural to the state of engineering and economic pragmatism. The hopes and aspirations of previous years were reduced to engineering realities with 42 reactors for production of power, materials testing, or research now in use or in advanced stages of construction in 8 countries and, in addition, some 25 more reactors being designed during the year.

The Geneva Atoms for Peace Conference was no small factor in bringing about world-wide acceptance of the realistic potentials of atomic reactors, especially for electric power generation. This conference was singularly noted for bringing together the nuclear technologies of the Eastern and Western worlds, a feat which has been quite impossible since 1920 in scientific and engineering activities politically less sensitive than atomic energy.

Other important conferences developed, such as the Congress on Nuclear Engineering and Science held in Cleveland, Ohio, in December. This congress indicated the breadth of the subject of nucleonics and its bearing on every phase of life. As, through engineers and scientists, the Geneva Atomic Conference bridged certain political boundaries in an unprecedented way, so also the Cleveland conference bridged the various scientific disciplines. More than 25 of the principal United States engineering and scientific societies demonstrated their interest in the future of nucleonics and its applications by participating in this Cleveland Congress.

The full scope of the 1955 developments in nuclear engineering is too great to outline properly in these brief paragraphs. Important work of the year, for example, varied from studies in the minute forces between neutrons and protons in calculating their interactions and modes of motion to the construction of Britain's first atomic power station, the giant Calder Hall pressurized carbon dioxide gas-cooled graphite-moderated reactor costing $50 million. The Calder Hall plant will, when completed next year, have a generating capacity of 50,000 kw. United States reactor power stations up to several times this capacity and employing a number of different types of reactor designs, fuels, coolants, and moderators are under construction at the present time.

High geometric efficiency of radiation detector makes it ideally suited to biological and other analytical tracer investigations

The first delivery of atomic electric power in the United States took place on July 18th. It was made by the West Milton Plant of the General Electric Company to the Niagara-Mohawk Power Company. Power may be supplied on a continuing basis from this plant to three public power systems in the Niagara area.

Test work has started on an "intermediate" and "advanced" submarine reactor, as well as a power plant for a large ship reactor. Meanwhile, the first atomic powered submarine, the *USS Nautilus*, has easily broken all speed records and traveled submerged from the New York area to San Juan, Puerto Rico, in 84 hours.

In nuclear machines other than reactors, an accelerator is under construction at Brookhaven National Laboratory capable of accelerating protons up to 25-billion electron volts.

In nuclear instrumentation, reliable high-speed 100-channel pulse-height analyzers have been developed during the year. The use of decade-counting tubes has been advanced through development of higher speed tubes. Reactor instrumentation and control is still far from standardized in the United States, but it appears that a sufficient number of similar solid-fuel heterogenous reactors would be built in England in the next few years to make some headway in standardizing and producing such controls and instruments in multiple installations on the same type of reactor.

Specific operating results to guide in preparing design parameters and selecting reactor types on a variety of nuclear reactors has been brought much closer during this past year.

SOLID-STATE DEVICES

The most important development in the field of semiconductor devices in 1955 was the development of the diffused base transistor. Straightforward attempts to produce a high-frequency junction transistor by narrowing the base region result in low collector voltage rating, high base resistance, and low power rating. In 1954, J. M. Early of Bell Telephone Laboratories disclosed a *PNIP* structure which provided isolation of the collector from the thin base region. The effect was to raise collector voltage ratings and lower collector capacitance.

This year a very practical means for obtaining a thin base region and collector isolation has been disclosed by C. A. Lee and others of the Bell Laboratories. By diffusing a low-resistivity base region into a high-resistivity body, the collector is isolated on the distant side and connection of leads is relatively easy. A small-area base connection ensures low base-to-collector capacitance; despite a relatively large-area collector, electrode operation in the 500-mc region with 100 milliwatts of power may be feasible in the future.

Temperature Measurements on D-C Armatures

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THE SIGNIFICANCE of the usual temperature measurements made on d-c armatures is somewhat vague. The amount of published data on this subject is limited. However, it was evident from the discussions on some of these papers[1,2] that some of the points under consideration were controversial, and that additional data would be helpful toward a better understanding.

This digest presents the results of a large number of laboratory tests showing the correlation among several different methods used for measuring temperatures on d-c armatures. It is believed that temperature measurements made with embedded thermocouples, read through slip rings, greatly enhance the validity of the correlation reported here.

The opportunity to make a rather exhaustive study of temperature measurements on five experimental motors was afforded. The motors involved were classified as General Industrial Motors, dripproof enclosed continuous duty rated at 60 C with class *B* insulation. These motors were self-ventilated with the fan exhausting out the end opposite the commutator. The nominal ratings of the machines ranged from 40 hp at 1,750 rpm to 200 hp at 1,150 rpm. After the validity of reading thermocouples through slip rings had been checked in the laboratory, the five experimental motors were equipped with thermocouples installed along the armature conductors. The ends of the thermocouple leads are brought out through a hollow shaft to a slip-ring assembly, as shown in Fig. 1, so that temperatures could be read while the armature was rotating.

Fig. 1. Slip-ring assembly

This organized procedure for making armature-circuit resistance measurements gave excellent repeat accuracy, and the tests could be accomplished in a very short time. With regard to thermometer measurements, the procedure employed is the one outlined in "Test Code for D-C Machines," AIEE Standard *501*, 1941.

In order to accumulate a large mass of data, the five motors described were subjected to a series of heat runs, not only at their nominal rating, but also at four different speeds below their base speed. At each speed, several runs were made at different load settings.

In conjunction with the plotting of test results, it was assumed that each type of temperature measurement bore a direct relationship among the other measurements taken. There is, for example, a fixed relationship existing between the rise by resistance and the rise by thermometer. A ratio between the two types of measurements involved were calculated for each test and the total averaged. The average ratios for the various combinations of measurements, along with their respective rms error or standard deviation factor, are

	Ratio	Rms Error, Per Cent
Temperature rise by resistance Temperature rise by thermometer	1.44	+22.9
Temperature rise by hot spot Temperature rise by thermometer	1.53	+22.5
Temperature rise by hot spot Temperature rise by resistance	1.10	+ 6.62
Temperature rise by resistance Average temperature rise from thermocouples	1.00	+ 4.1

CONCLUSIONS

1. Additional data correlating indirect-temperature measurements with hot-spot temperatures and correlation of the various methods of indirect measurements among themselves have been presented in the table.
2. An indication of the range of possible errors for an individual measurement is indicated also in the table.
3. The correlation between resistance and thermometer rises show excellent agreement with the recent revision of Table I of American Standards Association's standard *C50*.
4. The use of embedded thermocouples on rotating armatures adds to the validity of the data presented here over previous papers on this subject.
5. Based on the data presented in this digest, rise by resistance measurements can be made which show considerable improvement over those made by thermometers.

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Digest of paper 55-106, "Correlation of Temperature Measurements on D-C Armatures," recommended by the AIEE Committee on Rotating Machinery and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Winter General Meeting, New York, N. Y., January 31–February 4, 1955. Published in AIEE *Power Apparatus and Systems*, June 1955, pp. 391–8.

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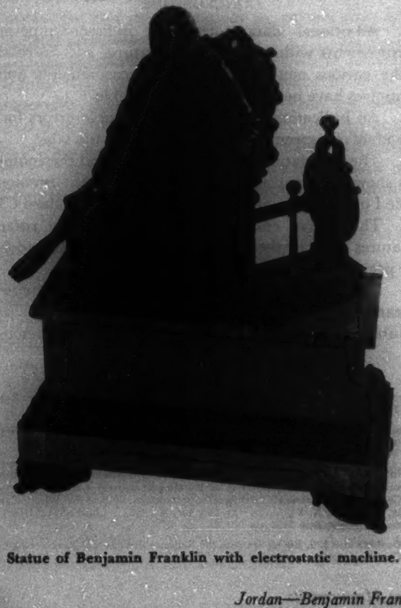
BENJAMIN FRANKLIN'S
Priceless Gift to Electrical Engineering

C. L. JORDAN

Benjamin Franklin was not only a brilliant scientist and inventor, but also a "practical man." His simple terminology and logical explanations of scientific phenomena provided a solid foundation for the study of electricity.

MANY PEOPLE have written of Benjamin Franklin's contributions to the science of electricity. They have told of his famous kite experiment, his theory of the "electric fluid," his invention of the lightning rod, his discovery of the law of conservation of the electrical charge for condensers, and his other pioneer works.

Few ever have written of what probably was his most important gift to electrical engineering—simple explanations that helped to build international understanding on how to apply this new science to useful purposes. More than any other one man, he contributed to the foundation on which millions could learn the facts about electricity and start it on its destiny as mankind's most useful servant. That is the glory of the engineer even more than the scientist, and "Poor Richard" was, above all else, a practical man.



Statue of Benjamin Franklin with electrostatic machine.

A LIFE-LONG OBJECTIVE

AMONG BENJAMIN FRANKLIN'S GREATEST TALENTS was his clear and logical simplicity. He disliked the tendency to create a mysterious "jargon" to describe each new phenomenon of science. To him, the use of big words, difficult to understand, was not a sign of learning, but self-conceit. His creed was written to John Perkins, February 4, 1753, in a letter on the origin of "Whirlwinds":

> "If my hypothesis is not the truth, it is at least as naked; for I have not with some of our learned moderns disguis'd my nonsense in Greek, cloth'd it in algebra or adorned it with fluxions."

Electricity in Franklin's day was a very mysterious thing. Its actions could have been given newly created and difficult terms or complicated explanations. Franklin planned differently. He determined upon the use of everyday words to describe the amazing actions of this new science. In his book, "Experiments and Observations on Electricity," he sought to remove all mystery and obscurity, presenting his findings to layman and specialist alike.

Probably for the first time in connection with electricity, the author used such common words as charge, discharge, positive, negative, condense, conductor, electric shock, electrician, nonconductor, plus, minus, and others.

This book became an important text in many American and European schools. It cleared away the awe and superstition that surrounded the "electrical fire" and made it the subject of wide discussion and interest.

Perhaps no one can say that Franklin's "Philosophy of Simplicity" was a major factor in the unbelievably wide development of the electrical industry. But it is true that electricity today is one of the most knowledgeable of all sciences in our daily pattern of living. The commonplace chores of the average home are performed with electricity by people who never have had to learn a difficult language of technical description. It is doubtful that any other science is as well standardized in terminology and equipment throughout the entire civilized world. For that, mankind is deeply indebted to Benjamin Franklin.

THE PRICELESS EXAMPLE

FRANKLIN'S PROCEDURE for the identification of electricity with lightning is a model of clarity and understanding. For countless centuries, human beings had feared the lightning as the "wrath of gods" or "a mighty convulsion of nature." Franklin brushed superstition aside in a few simple notes:

> "November 7, 1749. Electrical Fluid agrees with lightning in these particulars: 1. giving light. 2.

> colour of light. 3. crooked direction. 4. swift motion. 5. being conducted by metals. 6. crack or noise in exploding. 7. subsisting in water or ice. 8. rending bodies it passes through. 9. destroying animals. 10. melting metals. 11. firing inflammable substances. 12. sulphureous smell. The electrical fluid is attracted by points. We do not know whether this property is in lightning. But since they agree in all particulars wherein we can already compare them, is it not possible they agree likewise in this? Let the experiment be made."

In that logical, understandable way, Franklin cleared the mystery of thousands of years and did it by flying a kite that any schoolboy could make.

The appeal of this simplicity to the public was universal. Roger Burlingame in "The First Mr. American" tells of the enormous crowds which gathered on the streets of Paris to welcome the great "Doctor." They felt "he had exposed the magic shown that what had once been evidence of the wrath of God was but a natural and common thing. He had even caught some of it (or so they said) in a bottle!" Franklin's "electrical machine" is illustrated on the right.

Charles Kettering once wrote: "It was Benjamin Franklin who first formulated the theory that electricity could exist in two states, which he called positive and negative. All of our complex electrical equipment from electrical power to radio is explained by this theory."

ENGINEER EVEN MORE THAN SCIENTIST

"POOR RICHARD" KNEW, as few men do, that the way to popularize an idea was to apply it to the homely actions of everyday life. He was called the greatest scientist of his day, but we in engineering would have called him an engineer, for his main objective always was to find the "practical application of science for the benefit of man."

Consider, for example, the magnificent experiment that first demonstrated the uses of electricity for modern living. Franklin wrote to his friend, Peter Collinson, in 1749:

> "Chagrined a little that we have been hitherto able to produce nothing in the way of use to mankind [from electricity] . . . In a party of pleasure on the banks of the Schuylkill . . . a turkey is to be killed for dinner by the *electrical shock*, and roasted by the *electrical jack*, before a fire kindled by the *electrified bottle*, when the health of all of the famous electricians in England, Holland, France and Germany are to be drank in *electrified bumpers* under the discharge of guns from the *electrical battery*."

Here was the "spark" which showed the way to our modern electric kitchens, and the vast uses of electricity for heating, entertainment, and military purposes.

Perucca and Gori in "Pioneers in Electrical Communications" also attribute to Franklin one of the earliest attempts to send messages by electricity over wires. Even the failure of his experiment (possibly because of defective insulation) did not detract from the importance of the idea.

Franklin's electrical machine

AN ANNIVERSARY MESSAGE TO ENGINEERS

IT MAY BE PRESUMPTUOUS to write what we feel a great man would have said had he been alive during the celebration of his 250th anniversary. In this case, however, Franklin's beliefs and objectives were set down so clearly that it is necessary only to apply them to conditions today.

We know that the problem of world peace in the future is largely an engineering problem. Few expect that the threat of war can be eliminated until all countries share alike in the amazing developments of technology. Electrical, chemical, and mechanical servants will someday raise all living standards, lengthen our lives, and make them more pleasant (as Franklin once predicted).

Scientists and engineers can hasten that day by sharing their ideas (as Franklin taught) in language that is as intelligible to the unlearned as to the learned. Almost every study of attitudes in other nations confirms the fact that what people really want, most of all, is technical "know-how." Every engineer who can and does write simply helps materially to bring real peace closer to the world.

If Franklin were here today, probably he would be the first to emphasize this fact. All of his life was lived in that pattern. He shared his ideas generously with all countries through the great scientific societies of the 18th Century. No other American was elected to so many of these societies (25 in England, Scotland, France, the Netherlands, Germany, Russia, Italy, Spain, and America). He believed that free communication of ideas was man's greatest service to man and the duty of every scientist and engineer.

Today, we have advantages that Franklin never had in the large associations of scientists and engineers and their publications. The world needs more technicians who will learn to write in a way that is clear and inspiring to others in other lands. With a broad exchange of ideas will come the understanding that can bring peoples closer together and contribute to man's age-old search for peace.

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Secondary Network Equipment

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THE PROBLEM of servicing large concentrated loads has been met successfully in the past by using spot networks and raising the distribution voltage from 208 volts to 480 or 575 volts line-to-line. The use of 480 or higher voltage systems offers definite advantages in reduction of size and cost per kva of the secondary network equipment. This equipment includes the network transformer, network protector, relays, fuses, and limiters. Along with the advantages gained, the use of the higher voltage secondary-network equipment has presented certain problems in the design of this equipment. For instance, the network protector is basically a current-carrying device, but the use of the higher voltages requires a careful consideration of such design features as relaying and fusing. To the transformer designer, the use of the larger kva ratings made possible by the higher secondary voltages has presented such problems as maintaining minimum dimensions, providing low sound levels, and the consideration of more efficient cooling methods.

Raising the secondary voltage from 216 volts to a higher voltage such as 480 volts, allows the maximum transformer rating to be increased from 1,000 to 2,000 kva. Increasing the maximum transformer size which can be applied on a secondary network system gives several important advantages: reduction of associated equipment, facilities, and maintenance for the system itself, as well as reduction of transformer losses and weights per unit kva.

The degree of these advantages depends upon the system capacity. The advantages increase in importance as the system capacity increases. For one hypothetical system with a total capacity of 30,000 kva, the reduction of system transformer losses, weight, and volumes by going from 216 to 480 volts is a maximum of about 18, 25, and 12 per cent, respectively.

The basic design of network transformers is the same for the higher voltages as for the more common 216-wye voltage. There are several characteristics of the larger transformer ratings which necessarily receive a greater amount of attention than for the lower ratings. One of these is the transformer sound level. Since the 2,000-kva ratings on the 480-volt system will be used where a 1,000-kva rating would have been used on the 216-volt system, essentially the same sound level is required. This means that there will be an increase in cost and size of the transformer, reducing somewhat the size and weight advantages gained by the use of larger kva ratings.

Network protectors are built in several continuous-current ratings. The following tabulation gives the interrupting ratings for each at 500 and 600 volts, and represent an increase to take care of the larger possible fault currents as loads become more concentrated:

Continuous Current Rating, Amperes	Interrupting Rating at 500 Volts, Amperes	Interrupting Rating at 600 Volts, Amperes
300	20,000	
600, 800	20,000	20,000
800, 1,200, 1,600	30,000	30,000
2,000	35,000	
2,500, 3,000	60,000	

Basically, the network protector is an air circuit breaker and is a maximum-rated device. Since the circuit breaker is a current-rated device, the only effect of changing the voltage on the circuit breaker is to make the interrupting element adequate to handle the increase in voltage. The change in voltage makes no difference to the current-carrying parts, since the maximum design voltage is 600 volts.

The network protector is controlled by relays which automatically open and close the protector in response to circuit conditions. In 480- or 575-volt systems the potential and phasing coils are made to operate at these voltage levels. Past and present practice is to have relays with coils suitable for connecting either line-to-line or line-to-ground at the system voltage. This means that the relays are different for 216-, 480-, and 575-volt systems, and new relays were developed with different coil and external impedances for various voltages, which maintain the identical type of operating curves as on the 216-volt system.

Fuses are mounted on network protectors chiefly to guard against failure to trip when a fault occurs on the supply side of the protector. The fuses used on the 250-volt class of protector are, in general, not suitable for the 600-volt class because of their inability to interrupt fault currents within the interrupting ratings of the protector. Two types of fuses in use today are the alloy fuse and enclosed copper fuse.

On the 216-volt systems, it is frequently possible to design the system in such a manner that secondary faults will burn clear. Where the system cannot be so designed or where it is undesirable to have arcing faults burn the cable clear, network limiters are used. On systems above 250 volts, limiters are usually a necessity and 600-volt limiters are available for this application. The function of the limiter is to isolate faults on the network, and the limiter is a fuse applied with a higher than normal fusing ratio.

In conclusion, it may be said that the use of higher secondary-network voltages will give a more efficient application of secondary-network equipment. The industry acceptance of the higher secondary distribution voltages will be closely related to the over-all economics involved. Both 480- and 575-volt network systems have been proved in installation and the equipment will work satisfactorily with either small or large systems.

Digest of one of 11 papers in special publication S-66 recommended by the AIEE Transmission and Distribution and Industrial Systems Committees and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 11–15, 1954.

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Transformer Electrostatic Voltage Distribution

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R. J. COSSAART

ONE OF THE PROBLEMS in power-transformer design is the control of the distribution of electrostatic voltage, produced by surge voltages applied to the line terminals. For waves with a relatively steep front, this initial electrostatic distribution is, to a large extent, determined by the capacitance network formed between the winding elements, the core, and the tank structure. This digest describes the wide range of control of this distribution achieved in interleaved shell form windings by the proper application of static plates, as shown in Fig. 1.

They consist of a sheet of metal foil sandwiched between two sheets of pressboard. The sheets, termed "washers," are cut to the general contour of the actual coils of the winding. The foil contains a gap to avoid forming a short-circuited turn. Connection to the foil layer is made by means of the pigtail shown. The internal and external edges are protected by pressboard channels. Spacer blocks are glued to the pressboard washers to form oil ducts on either side of the static plate.

The original purpose behind the application of static plates was to control the distribution of the initial voltage within a transformer winding caused by surges reaching its line terminal; whereby, a plate is placed parallel to the line coil and connected to the first turn of the coil. It is then extremely effective in securing a uniform surge-voltage distribution across the face of the line coil and, therefore, in turn, between the coils of the whole winding. If the static plate were not present, the voltage distribution across the turns of the line coil would be determined by a capacitance network, consisting of the turn-to-turn and turn-to-ground capacitances.

Since surge voltages can be transferred electrostatically between transformer windings, it is frequently desirable to isolate the lower voltage windings from effects caused by surges to the high-voltage line terminal. Simply, the low-voltage line coil can be placed opposite the high-voltage-line static plate and provided with its own static plate.

The shielding effect of a static plate used in this manner is a result of the effective grounding of the low-voltage terminal through the surge impedance R of the connected low-voltage line. It is entirely independent of the decrease in voltage at points, as caused by the voltage-divider effect inherent in a capacitance network. This shielding effect can be expressed analytically in terms of shielding factors. The factors are functions of the surge impedance, the time constant of the network, and the times for crest and zero of the impulse.

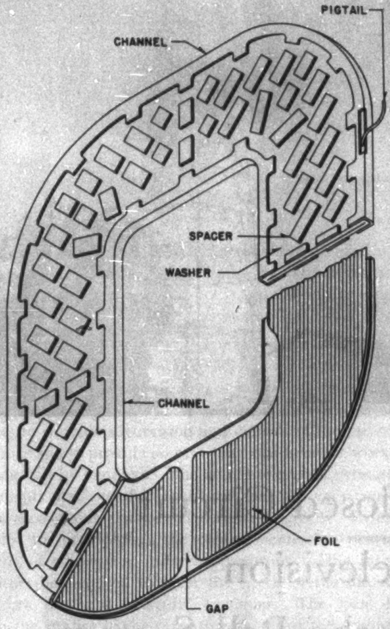

Fig. 1. Partial cutaway of static plates

Under normal conditions, the initial distribution within shell form windings is fairly uniform. This is caused by the small number of large surface-area coils used within the windings, with resulting low ratio of ground capacitance to series capacitance. Under certain special conditions, small portions of a winding may be separated from the main body of the same winding. When this occurs, additional capacitances to ground are introduced on both sides of the series connection, which tend to lower the initial capacitance voltage of the series connection. Since these capacitances are located at the ends of winding groups, they can be counteracted by the application of static plates.

Proper application of static plates in the interleaved shell form-fit transformer gives the designer a large measure of control over initial electrostatic voltage distributions. This control can be exercised over electrostatic surge transfer between the windings, as well as electrostatic distributions within individual windings. The concentration of mutual capacitance coupling at the ends of windings or winding groups in the interleaved shell construction greatly facilitates the control of surge transfer between windings by means of static plates.

Digest of paper 55-521, "Control of Electrostatic Voltage Distribution in Power-Transformer Design," recommended by the AIEE Committee on Transformers and approved by the AIEE Committee on Technical Operations for presentation in the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Publication in AIEE *Power Apparatus and Systems*, December 1955, pp. 1122–6.

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Closed-Circuit Television in the Bell System

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MEMBER AIEE

CLOSED-CIRCUIT TELEVISION is one of the many methods of transmitting intelligence that makes use of the plant of the Bell System. Closed-circuit television is differentiated from television broadcasting, familiar to all, in that the originator provides individual distribution of the television signal he has produced to specific preselected points. Several rather general fields of application of closed-circuit television have been found useful in the past. These may be outlined as follows:

1. The reproduction of outstanding entertainment events as they happen, at a large number of points on a country-wide basis.
2. The dissemination of information to groups of people scattered at numerous points throughout the country, such as for sales promotion or educational purposes.
3. The industrial use of the service on a local basis for transmitting information from one point, to another where it will be of more value in carrying out the business of the industry.

From the standpoint of problems involved and general use made of this service, closed-circuit television can be divided into two general groups. The first group makes use of intercity networks involving a number of viewing points located in different cities. The second involves local services connecting relatively few points, usually located within a single city or locality.

INTERCITY CLOSED-CIRCUIT NETWORKS

AT ITS INCEPTION in 1950, closed-circuit intercity network television was associated with theater television programs where such events as prize fights, football games, and grand opera programs were transmitted. The Bell System's job in providing these services is that of connecting the output of the customer-provided camera equipment at the pickup point to its transmission lines and then distributing it to theaters in different cities throughout the country designated by the customer. Here the circuit is connected to projection equipment also provided by the customer. Networks to as many as 133 points in 90 cities have been established for this type of service using monochrome transmissions.

In the years subsequent to 1950 there has been a gradual increase in use of closed-circuit television by other types of customers, such as a merchandising company in starting a new sales campaign, where its sales organization has been gathered at a number of local meetings. A manufacturer in introducing new models to his distributors located throughout the country has found this service useful, as have organizations involved in educational programs. The medical educational program associated with cancer surgery is an example. At the present time a large part of the closed-circuit intercity network services involve this latter type of customer.

Type of Facilities. The Bell System has a network of television channels which are used to furnish service both to the major television broadcasting networks and to closed-circuit users. Broadband channels are used and consist of radio relay or coaxial facilities. At the present time, there are about 68,000 channel miles of television facilities, 50,000 of which are on radio relay facilities and the remainder on coaxial cable or video pairs. This compares with 900 channel miles which existed in 1948, when network television was inaugurated. It is interesting that two one-way television facilities capable of carrying a television program in each direction can be used to provide hundreds of telephone message circuits.

The intermittent use now made of these facilities by closed-circuit television networks is proportionately small as compared to that of the broadcasting networks which are provided with full-time facilities. The facilities themselves, however, are of the same types and are used interchangeably. Detailed descriptions of the facilities used have been

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Full text of a conference paper presented at the AIEE Fall General Meeting, Chicago, Ill., Oct. 3–7, 1955 at a session sponsored by the Committee on Television and Aural Broadcasting Systems.

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published on several occasions, but it seems desirable to give a brief outline of each type used to complete the picture of how the service is provided.

Radio Relay System. Equipment known as the Western Electric *TD-2* radio relay system is used chiefly for those portions of the television channels which work on radio facilities. This system is capable of providing six broadband channels in each direction, and consists of successive radio links normally from 25 to 30 miles in length. Repeater stations, located at the end of each link, amplify the signal and transmit it to the next station. Separate antennas, designed to beam the radio waves along a narrow path, are used for receiving and transmitting at each repeater point for each direction of transmission. Thus, intermediate repeater points, ordinarily have four antennas. Antennas are mounted on towers of sufficient height to provide line-of-sight transmission, the height depending on the terrain encountered, with higher towers being required in flat country where advantage cannot be taken of natural elevations. The title picture shows a typical tower and radio repeater station.

The *TD-2* system uses frequencies in the 3,700- to 4,200-megacycle (mc) band transmitting on an FM basis. The available 500-mc band is divided into 12 one-way channels, the mid-band frequencies of which are 40 mc apart. Channels with adjacent frequency assignments transmit in opposite directions, thus producing six channels in each direction. In adjacent repeater sections the same frequencies are used with directions of transmission reversed. Such a plan conserves frequency assignments and reduces crosstalk between channels to a workable minimum.

To guard against interruptions, one channel of a system in each direction is usually assigned as a protection standby and automatically replaces the working channel whenever trouble is experienced.

Coaxial Cable Systems. A typical coaxial cable consists of eight coaxials in one cable sheath. Each coaxial is used to provide a one-way broadband channel capable of providing one closed-circuit television service. In regular use, for message facilities, two coaxials are paired together (one transmitting in each direction) to provide a two-way broadband channel to which frequency division multiplexing is applied to develop the individual message facilities. The coaxial cable consists of a copper tube with a copper wire located at its center. This wire is suspended throughout the length of the cable by insulators spaced about an inch apart. Fig. 1 shows the cross-sectional view of a typical coaxial cable.

There are two types of coaxial systems being used at the present time. The original system is known as *L1* and the later improved system known as *L3*. The *L1* system has amplifiers, used to compensate for attenuation in the coaxial, located approximately 8 miles apart and will transmit frequencies up to about 3.1 mc. The *L3* system uses amplifiers spaced approximately 4 miles apart and will transmit frequencies up to about 8.3 mc. The *L3* system will provide over three times as many telephone message circuits as the *L1* system using present standard terminal equipment.

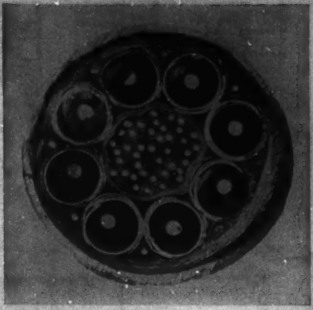


Fig. 1. Cross section; typical coaxial cable

Coaxial cables usually have a coaxial line in each direction set aside as a standby for replacing automatically any of the other lines in case of trouble, similar to the arrangements used with the radio relay system.

Television Operating Centers. The intercity television channels, whether they are of the radio relay or coaxial type, terminate in a central test point or operating center. Such centers are located at strategic points along the main routes to provide supervision and control of the use of the facilities and to provide points where maintenance work and testing can be handled. The actual television network assignments made to the broadband facilities vary considerably throughout the period service is given. Switching panels are provided at the control centers to provide a means of connecting different programs to the intercity facilities as required to meet the needs of the individual network or "closed-circuit" customer. The local loops from the studios to the operating center at the originating points and from the operating centers to the radio stations at other points are also connected to these same switching panels.

The switching panels are arranged so that all incoming circuits and all outgoing circuits in a particular operating center are connected to switches which enable any one or more outgoing circuits to be fed from any incoming circuit by pressing the proper switch control button. Fig. 2 shows a switching panel capable of handling 20 incoming and 24 outgoing channels.

Transmission Requirements. Television circuits are required to meet very strict limits with regard to both ampli-

The problems associated with providing facilities to meet the exacting requirements of closed-circuit television, as well as some of the uses made of this special form of television are discussed. The Bell System's progress in providing intercity and local facilities is reviewed.

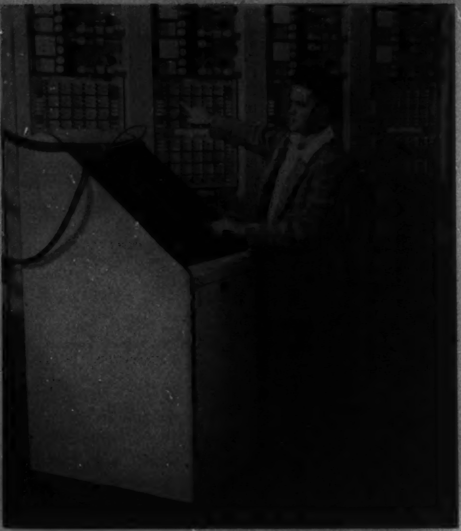


Fig. 2. Television switching panel

tude-frequency and delay-frequency characteristics in order to produce a satisfactory television picture. To maintain the channel facilities within required limits, routine tests are made at frequent intervals, using special testing equipment by which the networks are measured and necessary adjustments made to provide satisfactory transmission.

LOCAL CLOSED-CIRCUIT TELEVISION

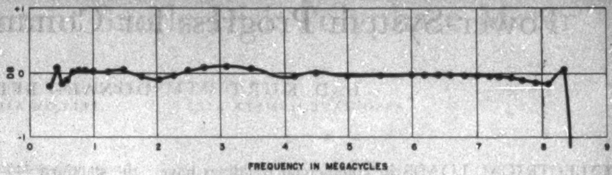
THERE ARE A NUMBER OF INSTANCES in industry where a picture of the progress of action at a particular point would be extremely valuable at some distant point of control. The cost of such an arrangement would determine to what extent it could be used. A number of services of this type have been established in the Bell System, including a complete package of television camera, transmission lines, and television receivers using equipment available on the open market.

Slow-scan video is one form of television transmission that may prove to be of value in producing a low-cost system where reproduction of constant motion is not necessary. Some trial uses are being planned for this equipment in connection with bank signature identification. Many banks have a number of branches located at different points in a community, thus developing a need for verification of an individual's signature and his current bank balance at any one of the different branch cashier's locations. The records of this type are usually kept at a central point and the desired information, upon request of a cashier, is placed in front of a camera and transmitted over the system to a television receiver at the requesting cashier's location.

A number of general uses of local closed-circuit television involving services already furnished or under consideration are as follows:

1. Traffic control at bridges, tunnels, and thruway junction points where lane or light controls can be used to clear traffic jams. The camera would provide a picture which would be transmitted to the control center indicating where traffic is the heaviest and corrective action is needed.
2. Control of steel rolling mill operations by use of a camera at the rolling equipment to provide a better idea at the control point of the actual conditions at the rolling equipment. The control operator can take corrective action when he notices a strip running out of line, thus preventing shutdown.
3. Camera placed to watch for jams and clogging on a complicated conveyor belt system, with a picture transmitted to a control center where corrective action can promptly be taken to avoid complete shutdowns.
4. Camera placed to show pictures at a remote control point of people and cars desiring entrance at a remote factory gate. Gates would be opened by remote control upon proper recognition.
5. Local distribution of television programs, as in a community television system.
6. Local distribution to a group of theaters of high-resolution color television. Savings in production costs can be made by this means.
7. Closed circuit television used as a means of assisting in the direction of battle strategy, as demonstrated in past Army maneuvers.
8. Camera used at tunnel toll gates to check truck licenses and amounts charged at centralized control point.
9. Camera used to record pressure gauge readings at a steam operated power-generating plant and to show picture at control center where regulation is accomplished.
10. Cameras used at cash registers at different chain stores, with pictures reproduced at main office where owner can watch transactions.

Fig. 3. Video amplifiers in telephone central office



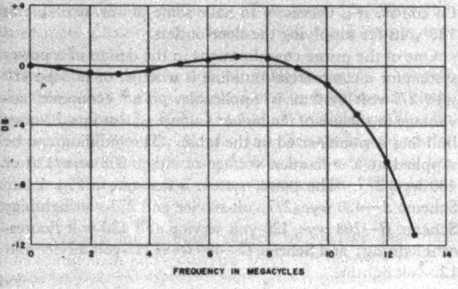


Fig. 4 (below). Measured transmission frequency characteristic of a typical TD-2 radio relay system. Fig. 5 (right). Measured transmission frequency characteristic of a typical L3 coaxial-cable high-frequency line

Local Video Facilities. Many of the local closed-circuit services have the camera and viewing screen located on the same premises, in which case no complicated video transmission facilities are required. In those cases where the distances between camera and viewing screen are longer, or where connections are required to several points in a city or to an intercity network, video facilities of two types are available. These are cable facilities and radio facilities. The cable facilities, referred to as the *A2A* or the *A2B* cable video transmission systems, provide circuits along trunk routes to main distribution points as well as to points of recurring interest from a television standpoint, such as ball parks, stadiums, public halls, theaters, or other points where the number of requirements for service have indicated a need for the facilities. Radio facilities are usually packaged portable equipment, which can be easily installed on building roofs or other points of vantage. Radio facilities are usually used for one-time pickups or for reaching points to which cable facilities have not yet been established. Using either of these two types of facilities, almost any point in a city can be equipped with video circuits in a reasonably short interval.

Cable Video Facilities. The *A2A* and *A2B* cable video transmission facilities require special polyethylene-insulated 16-gauge pairs and special amplifiers and equalizers. These video pairs are included in the makeup of the regular exchange telephone cables. The *A2A* system is designed to transmit frequencies with uniform response from about 30 cycles to 4.5 mc rolling off gradually to 7 mc where it is 6 db down. The *A2B* system transmits with uniform response frequencies from about 30 cycles to 8 mc with a gradual rolloff of 11 mc. Transmissions over these facilities are at video frequencies. The use of paired conductors balanced to ground helps to prevent low-frequency interference noise and crosstalk which would be encountered if coaxial cable construction were used for the same frequencies. Amplifiers are spaced 3.5 to 4.5 miles apart. An installation of video amplifiers associated with a cable video transmission system is shown in Fig. 3.

Radio Facilities. Radio systems used for video circuits in cities are usually single channel systems packaged for portable use so they can be installed and removed quickly. Frequencies in the 4,000 to 6,000 mc range are used, and systems capable of transmitting color television are available when required. The cover illustration shows an antenna installation made on the Empire State Building in New York, N. Y. From this vantage point, most of the points of interest in and around the city can be reached. The Empire State building is connected through cable video transmission facilities to the telephone company distributing center.

FUTURE PLANS

The future facility developments in closed-circuit television seem to be heading in two directions to achieve special objectives, one toward provision of facilities which will transmit broader bands of frequencies such as for the transmission of color pictures with more detailed picture structure, and the other in the direction of a facility to work with slow-scan video in order to provide a low-cost closed-circuit video service.

To meet the requirements of the former, the Bell System now has facilities which are capable of transmitting bandwidths somewhat greater than 8 mc in the *L3* coaxial cable system and the *TD-2* radio relay system. Fig. 4 shows the measured response of a representative *TD-2* radio relay channel, and Fig. 5 the measured response of a representative *L3* coaxial channel. Future systems, one of which is in the planning stage, will be capable of still greater bandwidths.

The uses that can be made of slow-scan television are still being developed and the frequency requirements will depend on the uses found most desirable. However, based on developments to date, it would appear that most requirements can be met by using existing plant facilities with modifications that can be made with relatively small expenditures.

With reasonable advance notice of requirements, the Bell System expects to be able to meet the needs that may develop in closed-circuit television with regard to both quantities of circuits and quality of transmission in both these fields.

Power-System Progress for Commercial Buildings

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ELECTRICAL LOADS in commercial buildings have grown in intensity so they now are equivalent to the load density of a metal-working industrial plant. With the advent of air conditioning in the commercial building, the type of equipment supplied by the power system is also similar to that found in an industrial plant. The logical question then is why should the same engineering principles not apply in both cases—that is, small load-center substations should be located throughout the commercial building, and should supply the load at the higher voltage.

Although the general approach to the power distribution problems of an industrial plant and a commercial building may be similar, there are several significant differences, such as: (1) the extremely high value of floor and volumetric space in a commercial building; (2) the limited space, floor to floor; (3) the size of the commercial building, both physically and electrically; and (4) the supplying of many commercial buildings at utilization voltage from a secondary network system.

Inasmuch as floor space in a manufacturing plant may be as valuable in dollars per square foot of first cost as in a commercial building, the volumetric difference because of ceiling heights is significant. In an industrial plant it is possible to locate substations over washrooms and in other places where overhead space is not required for production machinery; such space is not available in a commercial building. In many cases, the location of substations other than in the basement would require the use of valuable rentable floor space, which factor tends to relegate the substation locations to only one or two places in the building.

Thus, design of a power system with a higher utilization voltage would offer many advantages. It has been conventional practice to use 208 wye/120 volts almost universally for commercial-building power systems regardless of the size of building. With the development of the 480 wye/277-volt system and the 265-volt fluorescent lamp ballast, it has become economically advantageous in many cases to use the 480 wye/277-volt system. In this system, the standard 440-volt motors are used to drive machinery and the 265-volt fluorescent lamps, operated off the line-to-neutral connection, are used for general-area illumination. Of course, it is necessary to have some power available at 120 volts for supplying the floor outlets.

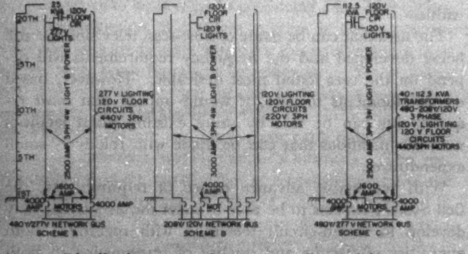

Fig. 1. Distribution system for 20-story office building supplied from secondary network

One of the prime considerations in the design of a power system for a commercial building is whether or not the 480 wye/277-volt system is applicable. The economic advantage in the use of the higher voltage system in a 20-story building is summarized in the table. The building can be supplied at a utilization voltage of either 208 wye/120 or 480 wye/277. The power system is laid out in Fig. 1 for: Scheme *A*—480 wye/277 volt-service and 277-volt lighting; Scheme *B*—208 wye/120-volt service and 120-volt fluorescent lighting; and Scheme *C*—480 wye/227-volt service and 120-volt lighting.

	Scheme A	Scheme B	Scheme C
Branch circuit wiring	$142,400	$161,600	$161,600
Panelboards and transformer	88,300	22,982	140,486
Entrance switchgear and risers	112,200	271,575	112,200
Motor control centers	126,100	174,750	126,100
Four 500-hp air-conditioning motors	26,400	29,100	26,400
Motor feeders	5,400	12,510	5,400
Approximately	$500,800	$672,517	$572,186

Saving of Scheme *A* over *B* = $171,717 or $28.6 per kva
Saving of Scheme *C* over *B* = $100,331 or $16.7 per kva

The higher voltage system is fundamentally the same as the 208 wye/120-volt system with all of the equipment in the 600-volt class. There are, however, several items that require consideration. One of the main considerations is the short-circuit duty of the equipment. This is important at either 208 or 480 volts. The short-circuit current for equal power is less at 480 volts than at 208 volts, but the effect of circuit impedance in limiting the short-circuit duty is less at 480 volts. All equipment used in the 480-volt system must have an assigned interrupting capacity equal to, or greater than, the short circuit available. This includes the small fuses in the branch-circuit wiring.

The small dry transformers rated 480–120/240 should include primary taps below rated voltage to obtain the correct voltage ratio. The transformers require special consideration as to their noise, and should be located on the solid inside core walls with resilient mountings.

The 480 wye/277-volt system, where applicable, offers many advantages. The savings that can be realized over a comparable 208 wye/120-volt system can exceed $30 per kva of demand, because of reductions in number and size of breakers, and bus size, lower per cent voltage drop per unit of current, and use of economical motors and starters.

Digest of one of 11 papers in special publication S-66, recommended by the AIEE Transmission and Distribution and Industrial Power Systems Committees and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 11–15, 1954.

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Design of a 2-Element Single-Disk Polyphase Meter

W. J. SCHMIDT

THE ART of metering polyphase circuits has developed to the point where it is possible to design a compact 2-element polyphase meter that is not only highly accurate but also simple to calibrate. This paper describes the three main phases of the design which contribute to this type meter.

Compactness is achieved by making use of a single-disk design and a unique method of compensating for interference proposed by B. E. Lenehan, Westinghouse Electric Corporation, Newark, N. J. Interference is caused by three separate interactions between eddy currents in the disk and fluxes from the electromagnet poles. The interactions are:

1. Voltage interference, caused by voltage pole flux interacting with eddy currents from the opposite voltage pole.
2. Current interference, caused by current pole flux interacting with eddy currents from the opposite current pole.
3. Voltage-current interference, caused by current pole flux interacting with eddy currents from the opposite voltage pole.

Voltage and current interference are eliminated by arranging the watt-hour meter elements symmetrically with respect to the center of the disk. Voltage-current interference is eliminated by a compensating winding applied to the voltage poles. The arrangement of the compensating winding with respect to the main winding is illustrated in Fig. 1. The voltage relationship in a compensated meter is shown in Fig. 2. The voltage-current interference effect produces the vector CE_{Bb}. The compensating windings produce an equal and opposite vector $E_{Bb}n_1/N_1 = E_{CN}$. Since the two vectors will always be equal and 180 degrees out of phase, the compensating windings will eliminate voltage-current interference for all phase relationships between the current and voltage applied to the two electromagnets.

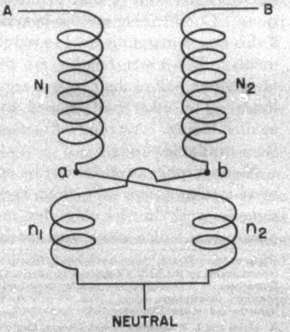

Fig. 1. Potential-coil windings for voltage-current interference compensation

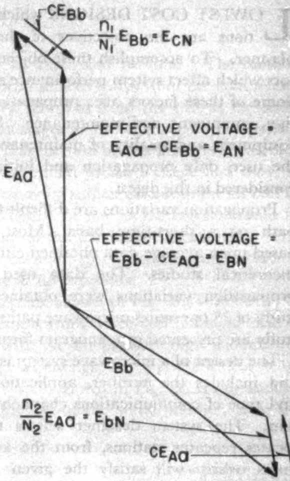
CE_{Bb}
$\frac{n_1}{N_1}E_{Bb} = E_{CN}$
EFFECTIVE VOLTAGE = $E_{Aa} - CE_{Bb} = E_{AN}$
E_{Aa}
EFFECTIVE VOLTAGE = $E_{Bb} - CE_{Aa} = E_{BN}$
E_{Bb}
$\frac{n_2}{N_2}E_{Aa} = E_{bN}$
CE_{Aa}

Fig. 2. Voltage relationship in a compensated meter

Adjustment of the 2-element polyphase meter is simplified by providing only one light-load slider and one phase balancer. This simplification is the result of designing the two adjusters to perform the specific function of calibrating a 2-element meter.

The light-load slider produces a constant compensating torque in a watt-hour meter. This constant torque will correct for "creep," friction, and the inherent response of any two electromagnets to varying load, all of which affect light-load calibration.

Phase balance in a 2-element meter is simplified if the torque of one of the electromagnets is used as a reference and the torque of the other electromagnet is adjusted to match the reference torque. Only one phase-balance adjuster is required to achieve this simplification.

Further simplification is achieved if the phase-balance adjuster is designed so that it changes the basic torque of its electromagnet without disturbing the relationship between light load, power factor, and full load. This is achieved by designing the adjuster so that it maintains the symmetry of the potential flux field and compensates for the changes in quadrature compensation as more or less potential flux is shunted from the disk gap.

Digest of paper 55-483, "The Design of a New 2-Element, Single-Disk, Polyphase Meter," recommended by the AIEE Committee on Instruments and Measurements and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Published in AIEE *Communication and Electronics*, September 1955, pp. 513–6.

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Parameters for Microwave-System Reliability

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LOWEST COST DESIGNS which meet user specifications are the objectives of the microwave system planner. To accomplish these objectives, each of the factors which affect system performance should be considered. Some of these factors are: propagation, initial system design, equipment, and maintenance. Since the selection of equipment and quality of maintenance are controlled by the user, only propagation and initial system design are considered in this digest.

Propagation variations are difficult to predict for a single path on a short-time basis. Most system designs are based upon average data obtained either from statistical or theoretical studies. The data used for the predicting propagation variations were obtained from a statistical study of 25 operating microwave paths. The results of this study are presented in nomogram form in Fig. 1.

The design of a microwave system is initiated by the user and includes the number, application, location, quality, and type of communications channels required in the system. The system designer selects tentative paths and locates repeater stations, from the available topographic maps, which will satisfy the given requirements. Path profiles are constructed, and tower heights necessary to provide 0.6 Fresnel-zone clearance over path obstructions are determined. Paths over water or exceptionally smooth terrain are avoided whenever possible. Path lengths usually vary between 20 and 40 miles.

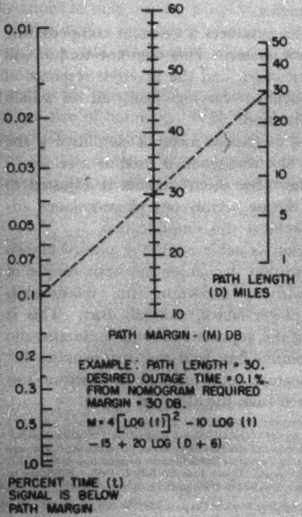

Fig. 1. Nomogram of predicted path outage time as a function of path margin and length. Nomogram applies to paths with 0.6 Fresnel-zone clearance during the worst fading month

The specified channel noise and outage time are divided equally between all paths common to the channel, so as to establish design objectives. From these objectives and manufacturer's equipment specifications, two required power levels are established. The receiver input power level for the path must equal at least that required to provide the path fading margin in Fig. 1. Also, it must be high enough to meet specified average noise per path. The larger of these two values establishes the power level at the receiver. The other power level is obtained by subtracting the fixed losses in the path from the transmitter power level. These fixed losses include filters and coupling, as well as free-space values. The difference between the required receiver power level and the transmitter power level less fixed losses represents the gain required from the antenna system.

Antennas and transmission lines are selected which provide a gain approximately equal to the required gain. The average values of path noise and outage time are adjusted to compensate for the differences between actual antenna-systems gains and required antenna gains.

After the performance is calculated for each path, as based upon the map survey, the actual tower sites are located, and critical elevations shown on the path profile are checked. This operation normally requires a visit to each site and a trip along each path; original path calculations being altered, as necessary.

Performance of each communications channel is calculated from the path data. The channel noise level and outage time, as caused by fading, are obtained from the sum of the noise and outages for all paths common to the channel. If each path is designed to meet the average requirements determined from the user specifications, the completed system will also satisfy user specifications.

In most cases, tower heights are used which provide at least 0.6 Fresnel-zone path clearance over obstructions. However, in some cases the calculated path margin is considerably in excess of that required to meet user specifications. Considerable savings in system cost can be realized if this excess margin is used to reduce tower-height requirements. The tower heights are decreased until approximately one half of the excess margin is used for diffraction losses. The other half is used to provide extra margin against fading. Average diffraction losses can be obtained from available curves.

Nomographic solutions for the equations used in microwave-system design save time, as well as simplify the designer's work in choosing the most economical system parameters which meet user specifications.

Digest of paper 55-516, "Microwave-System Parameters for Reliable Communications," recommended by the AIEE Committee on Carrier Current and approved by the AIEL Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Published in AIEE *Power Apparatus and Systems*, December 1955, pp 1100–07.

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High-Temperature Problems of Rotating Electric Equipment for Aircraft

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This article deals briefly with the systems that tend to make machines "environmental free" and, more specifically, with machines that in themselves tend to respond more slowly to environmental changes. Some of the problems encountered because of temperature and the particular nature of the machines themselves are considered, along with possible solutions.

WITH SUPERSONIC FLIGHT SPEEDS and continuous flight at altitudes in excess of 40,000 feet an everyday occurrence, attention is being centered on "environmental-free" machines and the problems encountered by the high temperatures existing throughout the machines.

An environmental-free machine desirably would be one that could maintain a constant steady-state temperature in all its components regardless of the properties of its surroundings. This would, of course, be a very difficult, if not impossible, machine to design and build. Therefore, whether a machine is environmental free or not can only depend on how closely the concepts are followed.

ENVIRONMENTAL-FREE MACHINES OR SYSTEMS

AT THE PRESENT TIME, aircraft generators fall into four general categories: (1) air cooled; (2) liquid cooled; (3) evaporative cooled; and (4) thermal lag. With exception of the thermal-lag machine, which is designed to give rated load for a definite period of time, these machines are considered as continuous duty and are expected to deliver their rating for extended periods of time.

Air Cooled. The air-cooled machine shown in Fig. 1 is a d-c generator, incorporating improved cooling techniques, such as extended surfaces on the brush boxes, interpoles, and rotor passage. However, the air-cooled machines in themselves are not environmental free. Although if placed in a suitable system, they can become such. A suitable system might be arrived at by using bleed air, refrigeration, or any other system that maintains relatively low air temperature, high pressure, and does not permit the weight rate of air to decrease.

In considering the bleed-air system, the logical choice for high-pressure air is from the main-engine compressor. However, the air leaving the compressor would be at too high a temperature to use directly for cooling, so methods would have to be applied to first cool the air before passing it over the machine. This air, of course, could be cooled by an intercooler or an expansion turbine. The method shown in Fig. 2*A* utilizes selective taps from the compressor so that the air may be removed from the exit at the start, and then from earlier stages as the engine and compressor come up to speed.[1] This method means that the air turbine can be designed for a limited pressure range and may, in itself, be capable of removing sufficient heat so the air can be used for cooling. Whether or not an intercooler would be needed would depend on the particular installation. This method also offers a constant-speed drive for an alternator and adequate cooling at no extra cost.

The cabin bleed system, shown in Fig. 2*B*, would also be applicable if the temperature were low enough, and it probably would be with the air pressure high enough and the quantity of air great enough.

The refrigeration system shown in Fig. 2*C* is still another method that does this job in the same manner, only this time in a closed recirculating system. The degree to which this system would be environment bound would depend in part on how the condenser is cooled.

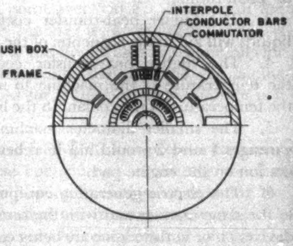

Fig. 1. Improved air-cooled machine

Liquid Cooled. The liquid-cooled machine as it is being designed today is an attempt to make the generator less dependent on the environment. The final argument, of course, would be that all heat generated will ultimately have to be dumped overboard and, therefore, this machine is environment bound. This type of machine, however, is fast coming into its own and the future should see this machine being used more and more. Basically, this type of machine consists of the standard generator or alternator, with the liquid being circulated through the various components (Fig. 3). The oil enters the machine at the mounting pad, is circulated through the stator and rotor, and is then returned to the engine at the mounting pad.

The liquid used would most commonly be the engine oil or hydraulic oil, and the heat picked up in the generator would be carried to whatever heat sink is ordinarily being

Revised text of paper DP55-346 presented at the AIEE Middle Eastern District Meeting, Columbus, Ohio, May 4–6, 1955, and recommended for publication by the AIEE Committee on Air Transportation.

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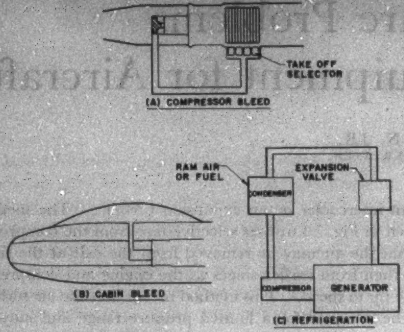

Fig. 2. Air-cooling systems

used for the liquid. Some of the advantages for the liquid-cooled machine are:

1. This type is primarily smaller in diameter and possibly shorter in length, because of the elimination of large air-flow passages.
2. The elimination of the 3- to 4-inch diameter ducting and shrouds of blast-cooled equipment is made in favor of small tubing.
3. The higher heat-transfer coefficients realized with liquids will aid in the reduction of the size of the machine.
4. The higher heat-transfer coefficients will permit the temperature of the machine to more nearly approach the temperature of the coolant in the liquid-cooled machine.
5. The smaller diameter machine mentioned in advantages 1 and 2 would aid in relieving some of the congestion on the engine pad.
6. The electric generating equipment would be cooled in the same manner and with the same medium that other devices on or in the engine are being cooled.
7. A recirculating system, as this is, can be adapted to reject heat to any available heat sink and to switch from one heat sink to another, as demanded by the range of environments encountered.
8. A machine of this type once designed can be used in many varied installations and only the heat sink and liquid supplied need to be varied.

Fig. 4 shows a comparison in size of liquid-cooled and air-cooled 40-kva alternators.

As an example of how this recirculating system would aid in airplane performance by permitting the use of different heat sinks, the case of a supersonic fighter is considered. Under conditions of supersonic flight, the inlet air temperature to a liquid-air heat exchanger would be too high to offer cooling; however, at this same time the fuel consumption by the engine would be great enough to permit the use of this fuel as a heat sink. Then under conditions of lower flight speeds, when the fuel consumption is lower, the use of the liquid-air heat exchanger would be advantageous. In addition to the cooling, added performance of the aircraft itself would be realized, for under supersonic flight conditions no air intakes would be present to create additional drag, while at subsonic speeds the use of air intakes would be tolerable.

Believing that this type liquid-cooled machine would be the answer to many current and future problems, Jack and Heintz, Inc., began obtaining experience in 1950 when a 30-volt 300-ampere d-c generator weighing 66 pounds was built, and used as an experimental model to investigate some of the problems involved in liquid cooling. Since that time, six liquid-cooled machines—two d-c generators and four alternators—have been built or are in the process. The generators are rated as: 12,000 rpm, multi-output; and 8,000 rpm, 28 volts, 75 amperes; the alternators as: 12,000 rpm, multi-output; 12,000 rpm, 14 kva; 6,000 rpm, 40 kva; and 8,000 rpm, 20 kva.

Evaporative Cooled. Fig. 5 shows an evaporative-cooled machine with the liquid being introduced, heated to the boiling point, evaporated, and exhausted as a vapor. Some of the features that make this machine attractive from a thermal viewpoint are:

1. Heat-transfer coefficients during the boiling process are 20 to 200 times those realized with air, i.e., in the absence of air, water evaporating from clean surfaces may have heat-transfer coefficients of 2,000 Btu per hour—(degrees F per foot).[2]

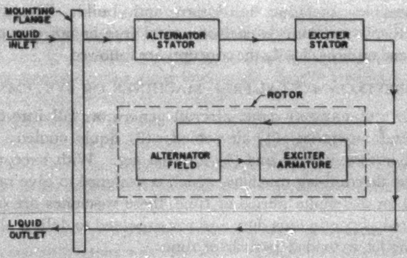

Fig. 3. Liquid-cooled machine

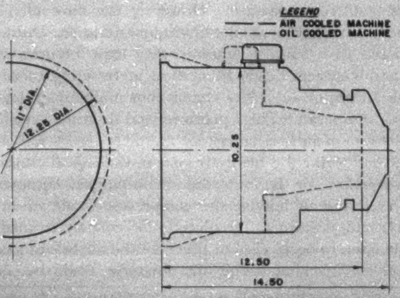

Fig. 4. Comparison of liquid- and air-cooled 40-kva alternators

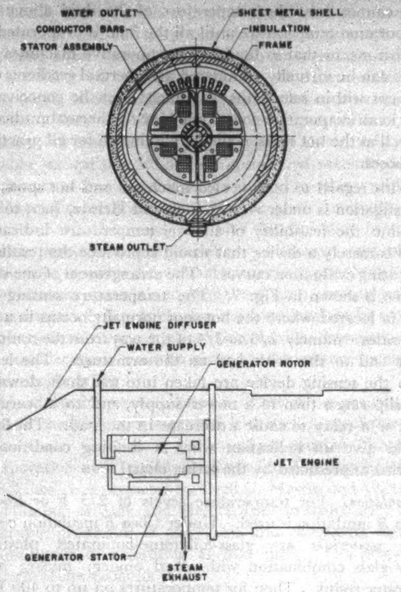

Fig. 5. Evaporative-cooled machine

2. If the machine is completely insulated, it represents the closest approach so far to an environmental-free machine.
3. By utilizing the heat of vaporization as the heat sink the weight of coolant, a 30-volt 400-ampere machine of 65 per cent efficiency would only use 22 pounds per hour.
4. As the altitude is increased the temperature level of the machine decreases because of the lower boiling temperature at lower pressures.
5. Since cooling takes place by the vaporization of a fluid, the temperature of the coolant remains constant during the process of heat absorption, which insures a maximum mean temperature difference between the machine surface to be cooled and the coolant.

Machines of this type are being built and operated successfully; two of these are a 12-kva a-c generator; and a 30-kva a-c generator. Both machines are equipped with temperature sensing and control devices to regulate the water flow to the generator.

Thermal Lag. This type of machine is designed for use when the duration of flight is reasonably short, and where there is no cooling available, such as in a missile. The machine itself merely uses its own parts to store the heat and after a given period of time will fail unless its output is terminated. One of these machines, is being built now. It is an a-c generator, rated at 8 kva, 120/208 volts, 12,000 rpm, weighing 52 pounds, and has an operating time of 30 minutes without any cooling at all.

PROBLEMS AND SOLUTIONS

REGARDLESS of the method used to cool the machine, the higher the temperature level the machine is able to withstand the smaller, in both space and weight, the cooling system will be. For this reason then, the generator pushed to as high an operating level as possible until one of the components reaches its critical limit. In the perfect machine, of course, when this temperature limit is reached, each of the components of the machine is at its critical limit. Consequently, the problem spot shifts from component to component as each is improved or as better cooling methods are devised to put the critical limit where required. However, two of the major concerns because of these high temperatures are the bearings and insulations, and the temperature-level problems are aggravated by the location of the hot spots and thermal gradients. Other problems arise at the brushes and in the strength requirements of the high-speed rotating parts.

Although liquid- and evaporative-cooled machines aid in the solution to some of these problems, they bring problems of their own. For example, in the evaporative-cooled machines there is the compatibility problem of the evaporant with all the components of the machine, plus the necessary requirements placed on the evaporant itself such as high latent heat of vaporization, boiling temperatures below 350 F at sea level, and a freezing point below −65 F. In a liquid-cooled machine the fluid requirements would be a freezing point below −65 F, viscosity—mobility at −65 F, and a flash point over 350 F. Further, in the liquid-cooled machine, sealing is a problem. This is particularly a problem if the liquid used is engine oil, for in this case if any oil leaks into the machine the engine may well become starved for oil and an engine failure will thus result.

Bearings. Bearings are one of the components that may well become the critical component. If the temperature level does not limit the bearing operation by reducing the hardness of the balls (normal bearings are drawn at 325 F), it does make the bearing very vulnerable to any other factor that may cause bearing failures. Temperatures in the order of 300 F will cause the balls to lose their hardness, followed by the loss of their shape, which is followed by bearing failure. Some of the factors that cause failures are dirt, misalignment, improper fits on shaft, and improper fits in the housing. Of these, the latter two will be ag-

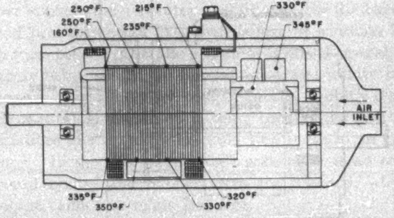

Fig. 6. Temperatures in a typical blast-cooled d-c generator

gravated also by thermal gradients across the bearing, and the higher temperature levels may cause severe temperature gradients across the bearing unless the locations of heat sources and sinks are carefully considered. On blast-cooled machines the drive end bearing is usually the one subjected to the higher temperature level, for the blast air is normally directed over the antidrive bearing before it cools any other component and, consequently, is at a higher temperature when it reaches the drive end bearing. On liquid- and evaporative-cooled machines both bearings would become critical at the same time, for the temperature level of the coolant would be the same at both bearings. These methods of cooling also make it possible for the designer to eliminate virtually any thermal gradient across the bearing. Further, on liquid-cooled machines the trend is to only one bearing, namely, the antidrive bearing with the other bearing being supplied by the driving device at the spline; thus, more care can be taken in seeing that this bearing operates in the most favorable conditions.

Temperature Gradients and Hot Spots. Temperature gradients and hot spots must be eliminated before the design of a perfect machine can be realized. Naturally, anywhere there is a hot spot the insulation may fail, the materials may yield strengthwise, and the fits may be lost. Further, the thermal gradients may set up internal stresses great enough to fail some component, such as the bearings mentioned previously. An indication of how the temperature varies throughout an air-cooled machine may be seen in Fig. 6.[3]

Even with careful design, it is practically impossible to eliminate hot spots in blast-cooled machines. Further, in these machines temperature gradients may be set up in either the axial or radial direction, and they may change depending on load and available air flow. In a liquid-cooled machine the gradients are more likely to occur in the radial direction, and they are dependent mostly on load since the flow rate of the coolant would be constant regardless of altitude. Further, the temperature rise of the liquid would be small enough so that, regardless of how the liquid is circulated, the last component to be cooled will have nearly the same temperature liquid available to cool it as had the first component. In an evaporative machine this is even more true, for during the boiling process all the heat going to the fluid merely goes into the latent heat of vaporization and cannot raise the temperature of the fluid above the evaporation temperature until all the fluid is evaporated.

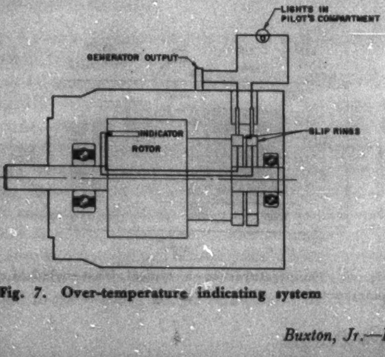

Fig. 7. Over-temperature indicating system

This means that in liquid and evaporative machines hot spots can be virtually eliminated and thermal gradients can be kept within safe limits. It might even be conceivable that in an evaporative-cooled machine the thermal gradients, as well as the hot spots, could be eliminated for all practical purposes.

With regard to blast-cooled machines and hot spots, an investigation is under way at Jack and Heintz, Inc., to determine the feasibility of an over-temperature indicator. This is merely a device that would reproduce the results of the rating evaluation curves. The arrangement of one such device is shown in Fig. 7. The temperature sensing device is located where the hot spot normally occurs in a d-c generator—namely, 2/3 to 3/4 of the way from the commutator end to the drive end on the armature. The leads from the sensing device are taken into the shaft, down to the slip rings, then to a power supply, and to a warning light or a relay to cause a decrease in the load. The light would give an indication when a limiting condition is reached as predicted by the rating chart.

Insulation. For temperature levels of 275 F or lower, Class *B* insulation is used. Under Class *B* insulation come such materials as: glass-milamine-laminated plastics; mica–glass combination with alkyd binder; mylar; and polyester resins. Then for temperatures on up to 400 F is Class *H* insulation, which is primarily silicones. For temperatures up to 500 F, Teflon might be used as wire coatings, tapes, etc. For still higher temperatures, ceramics, such as glass-bonded mica, might extend the upper limit to 700 F. However, at the present, this appears to be the upper limit for temperature as far as insulations are concerned. Naturally, these higher temperatures will give higher machine losses and so lower efficiencies, but the decrease in efficiency does not appear to be great enough to rule out the use of these higher temperatures. The use of ceramic materials presents problems in that they are formed and, as such, do not make as compact or as flexible a package as do other insulating materials, so their use will be postponed to the very last.

A further problem arises in the use of insulation. Basically, the insulation is used to prevent shorts, grounds, or high-voltage breakdowns of the electric system. In some cases, the thickness of the insulation is governed by the electrical job it must do, and in other cases it is governed by the handling and techniques that must be used in installation. However, in general, the thicker the insulation the higher the temperature it must be able to withstand for insulation is a good thermal barrier (it has low values of thermal conductivity) and, therefore, inflicts higher temperature levels. By using thick insulation, insult is added to injury, for the higher temperature levels will cause higher resistances and the I^2R losses will be increased, thus making more heat to be transferred and again causing higher temperature levels.

This means that in the design of generators a careful study must be given to how much of a certain insulation is needed electrically, then to see what temperature level is called for, and finally to see if this is enough so that installation scrapes at assembly will not cause electric shorts or grounds. By watching these factors carefully, the temperature level in the machinec an be kept to as low a value as possible and, for a while, the special classes of insulation may not be needed. This will eliminate, for sometimes at least, the problem of how to handle ceramics. Teflon might be useable, except that it has been discovered recently that it tends to cold flow and this may well lead to other problems.

These considerations must also be given for liquid- and evaporative-cooled machines, plus the fact they have the added problem of compatibility. Although most of the insulations on wires show no effects when exposed to several liquids, some materials in laminated form tend to peel or delaminate. It is possible that combinations can be worked out between the various materials available; however, careful considerations must be given to temperature levels and methods of cooling.

Liquid and Evaporative Problems. One of the major problems in these types of machines is the selection of the fluid to be used. On July 9, 1953, a paper entitled "Survey of Evaporative and Liquid Coolants for Rotating Electrical Machines" was prepared by Cecil G. Martin and Valentine F. Hambor of Jack and Heintz, Inc., in which they listed desirable properties of the fluids and compared these to fluids under consideration at that time. The properties desired of the coolants were:

Evaporants:

1. Heat of vaporization must be in excess of 300 Btu per pound.
2. Boiling temperature must be less than 350 F at atmospheric pressure.
3. Freezing point below −65 F is desirable.
4. The following properties must be known insofar as possible to aid in selection of the best fluid and to determine how it could be best applied: degree of toxicity; degree of corrosiveness to copper, aluminum, magnesium, and iron under atmospheric boiling conditions; effect on life of high-temperature varnishes at atmospheric boiling conditions; freezing point; vapor pressure vs temperature; heat of vaporization; availability; cost; thermal conductivity; specific heat; density; dielectric strength; viscosity vs temperature; and chemical formula.

Liquids:

1. Viscosity, mobility at −65 F is essential.
2. Freezing point, −65 F or lower is desirable.
3. Flash point, should be over 300 F.
4. Vapor pressure at 300 F.
5. Corrosiveness to iron, copper, aluminum, and magnesium is undesirable.
6. The following properties should be known: specific heat; thermal conductivity; dielectric strength; boiling temperature at 14.7 pounds per square inch absolute; density; availability; cost; and lubricating properties.

In the field of liquids it was concluded in the survey mentioned that Orsil *BF-1* appeared to have the widest range of applications for use as a recirculating liquid. Today, in addition, fluids meeting specifications *MIL-L-7808* are being used as a recirculating liquid. The following is a comparison of these two liquids for a few of their properties:

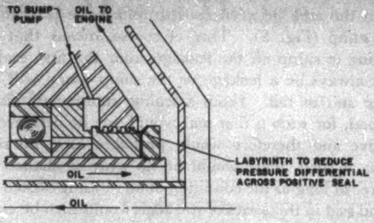
TO SUMP PUMP
OIL TO ENGINE
LABYRINTH TO REDUCE PRESSURE DIFFERENTIAL ACROSS POSITIVE SEAL
OIL
OIL

Fig. 8. Two-seal method of protecting against positive seal failure

Property	Orsil BF-1	MIL-L-7808
Pour point, F	−100	−75 max.
Viscosity, centistokes		
−65 F	1,400	13,000 max.
−40 F	260	
100 F	618	11 min.
210 F	214	3 min.
Flash point, F	395	365 min.
Thermal conductivity, Btu/hour/square foot per degree F/foot	0.085 (assumed constant)	0.084
Specific heat, Btu/pound per degree F		
0 F	0.25	0.30
110 F	0.44	0.445
250 F	0.55	0.495
610 F	0.80	0.56 approx.
Dielectric strength, kv	35	
Density, pounds/cubic feet		
60 F	55	58
320 F	54	51.4

To further help evaluate these two fluids, tests were conducted to determine the compatibility of these fluids with some of the materials that might be used in the construction of generators. Insulations, varnishes, paints, laminates, molding compounds, tapes, lubricants, and some synthetic rubber compounds were checked, with the *MIL-L-7808* oil appearing to be the better in the comparison. But, however, each application would have to be considered before the final selection is made. Conversely, if the liquid is known, then certain selections will be necessary to obtain the best compatibility of the generator components and this liquid.

A serious problem arises in liquid-cooled machines when the job of sealing is considered. This problem is serious from several standpoints: (1) Within the generator the type of liquid used may well be harmful to insulation, bearings (if grease lubricated), and commutation. (2) If leakage is severe enough, the generator may fill with the fluid and this would probably result in a shaft failure or windings being torn from coils. (3) If the generator is one of several components being cooled by this liquid, a seal failure in the generator may ruin other components by robbing them of coolant. (4) If engine oil is being used as the coolant, a seal failure in the generator could well result in an engine failure. In the case of the static seals there is no reason, if compatibility and temperatures are watched, why the machine cannot be made leak free.

One method of sealing that might be acceptable would call for two rotating seals in series with a sump pump working in the area between seals to return the leakage liquid to a sump (Fig. 8). This, of course, means that if one is going to sump off the leakage from the first seal there must always be a leakage or the sump pump will lose its prime and/or fail. From a sealing standpoint this is not too bad, for such a first seal would not be designed to be positive and therefore would probably have no rubbing parts; as such, there would be no wear or chance of seal failure, so long as the condition of no rubbing existed. The second seal in this series of two seals would then be expected to provide a positive seal. It could possibly approach this job for, with the sump pump working on the fluid, the quantity of oil reaching this seal might not be much more than required to lubricate and cool the seal itself.

As far as liquid leakage within the generator is concerned, the greatest problem is with slip rings and commutators. To protect these components from liquid leakage, an overboard drain could be located between the positive seal and these components. A further refinement would be to pressurize the inside of the machine slightly above atmospheric to insure flow out from the inside. This addition would also make the liquid-cooled machine explosion proof, since it would be impossible for contaminated vapor to leak in through the drains against the higher pressure.

CONCLUSIONS

BEFORE the proper machine and cooling system is determined, such things as maximum operating altitude, maximum flight speed, maximum ambient temperatures the machine might be exposed to, maximum operating time, duty cycle for the machine, and the length of time any one of the maximum conditions might be expected to exist must be known.

It is apparent from the discussions of the various types of machines that each has its advantages and disadvantages. For low-altitude low-speed flight the blast-cooled machine will still do its usually fine job. For high altitudes and high-flight speeds of sufficiently short duration these machines can still be used, but flight and load cycles must be checked against the evaluation charts to pick the proper machine. Of course, under these conditions it is time to start thinking of liquid-cooled machines. Then the ultimate heat sink must be considered to determine the temperature level of the liquid that can be maintained. This, along with a knowledge of the liquid to be used, will quickly tell whether the liquid-cooled machine considered will work. It is to be remembered that some of the liquid-cooled machines are designed to operate with inlet temperatures up to 350 F, and all are designed to operate with inlet temperatures to 250 F. The amount of oil required by these machines will vary depending upon the temperature and type of oil to be used and on the pressure drop available.

When the flight speed and altitude become very high, then it is time to consider the thermal-lag machines. The basic thermal-lag machines are used for the short-time flight, as mentioned, and the evaporative machines might be considered thermal-lag machines of varying time lengths depending upon the amount of evaporant that is required by the machines as compared to the amount that can be carried.

It must be remembered, however, that none of these machines have been designed to fulfill the entire range of requirements, but that these various types of machines are intended to supplement each other and to offer solutions to various types of installation and environmental problems. Therefore, each particular aircraft must be examined carefully to decide what type of cooling system will involve the least penalty to the performance; then the proper generating machine can be selected to meet the requirements presented by the cooling system and by the electric load.

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3. Temperature Distributions and Heat Transfer in a Blast-Cooled Generator, **J. R. Barnum, O. E. Buxton, Jr.** Cooling of Airborne Electronic Equipment, vol. 1, Second Conference at Ohio State University, June 23–24, 1953, p. E-6-1.

Miniature River Used in Water Intake Studies

A two-mile stretch of a West Virginia river is flowing in miniature in the hydraulic engineering laboratory at Cornell University, Ithaca, N. Y. The model was built to find ways of keeping debris out of a power plant's water system.

The plant, part of the Appalachian Electric Power Company, is on the Kanawha River near Glasgow, W. Va. It produces power from coal, but uses water from the river for its cooling system.

Professor Marvin Bogema (center) supervised the study. Others (left to right) are M. J. Hroncich, L. F. Smith, and L. E. Hovi of the American Gas and Electric Service Corporation, which sponsored the study, and H. C. Skaggs, Jr., manager of the Kanawha River plant of the Appalachian Electric Power Company.

Induction Torque- and Servo-Motor Design

GERALD WEISS
ASSOCIATE MEMBER AIEE

IN CERTAIN APPLICATIONS for an induction motor, the performance at standstill is of predominant interest. A control motor, such as a torque motor or servo motor, falls into this category. In designing such a motor, one of the usual goals is to obtain maximum stall torque. A better criterion is to maximize the ratio of stall torque to stall input power, because the allowable power dissipation of the motor is essentially invariant. This criterion is used to derive the optimum rotor resistance, the optimum number of poles, and the optimum air-gap diameter of a control motor with prescribed outline dimensions.

The analysis of polyphase induction-motor performance at standstill is based on the equivalent circuit of Fig. 1. The stall torque is proportional to the power dissipated in the rotor resistance R_2. The ratio of stall torque to stall input power, referred to as "torque-per-watt," is then proportional to the fraction of total power dissipated in the rotor, namely:

$$T/W=\frac{p}{4\pi f}\cdot\frac{W_2}{W_1+W_2+W_m} \qquad (1)$$

where

f = frequency
p = number of poles
T = stall torque
W = total stall input power
W_1 = primary motor power dissipation at stall
W_2 = secondary motor power dissipation at stall
W_m = mutual motor power dissipation at stall

An ideal torque-per-watt can be defined as: the torque-per-watt of a motor in which all the stall power is transferred across the air gap; that is, $W_1=W_m=0$. The ratio of actual torque-per-watt to ideal torque-per-watt is then defined as the torque-per-watt efficiency y, where

$$y=\frac{T/W}{(T/W)_i}=\frac{W_2}{W_1+W_2+W_m} \qquad (2)$$

Then

$$T/W=\frac{p}{4\pi f}\cdot y \qquad (3)$$

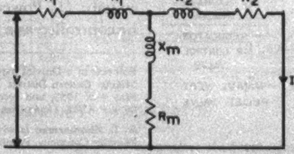

Fig. 1. Equivalent circuit of the polyphase induction motor at standstill

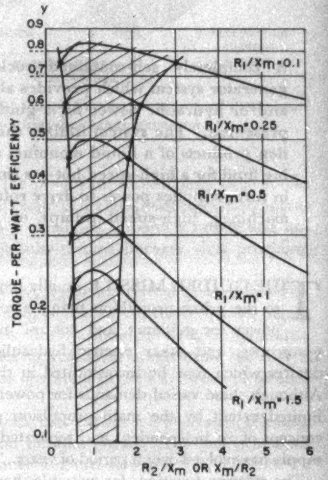

Fig. 2. Torque-per-watt efficiency vs rotor resistance

In analyzing the requirements for a control motor, it is found necessary to maximize the torque-per-watt efficiency. Referring to equation 2 and to Fig. 1, it is seen that this is simply an impedance-matching problem. The maximizing procedure leads to the result that the optimum rotor resistance is equal to the air-gap reactance X_m. The peak is broad, as can be seen from Fig. 2, where the shaded area represents the range of rotor resistance values for which the torque-per-watt efficiency is within 10 per cent of the maximum. This noncritical relationship justifies the simplifying assumptions and permits the use of this method even for the smallest motor, where precise calculation of parameters is difficult.

When the maximum torque-per-watt efficiency is substituted into equation 3, there results an expression for T/W which depends basically only on the number of poles and on the air-gap diameter. This relationship is used in analyzing two different kinds of control motors: (1) a torque motor, where it is desired to maximize stall torque; and (2) a servo-motor for a low-accuracy servo, where it is desired to maximize motor viscous damping. It is shown how these analyses lead directly to expressions for the optimum number of poles and optimum air-gap diameter.

By basing the design of control motors on torque-per-watt and torque-per-watt efficiency, a direct determination of certain major motor parameters is achieved, and the usual trial-and-error procedures can be discarded.

Digest of paper CP55-506, "Optimum Design of Induction Torque-Motors and Servo-Motors," presented at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955, and recommended for publication by the AIEE Committee on Rotating Machinery. Published in AIEE *Power Apparatus and Systems*, October 1955, pp. 809–15.

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Advanced Concept of an Accessory Power Supply for Guided Missiles

R. L. ZIMMERMAN

A completely self-contained rocket-type gas generator system which provides all the electric and/or hydraulic power for a guided missile is presented. The system utilizes the decomposition products of a liquid monofuel as the working fluid for a high-speed hot-gas turbine which, in turn, supplies power to drive rotating electric machines, high-speed pumps, or other loads.

THE GUIDED MISSILE usually requires, in addition to the prime propulsion plant, a source of accessory power for guidance and control mechanisms, fuses, gyroscopes, and other electric hydraulic, or pneumatic devices which may be incorporated in the missile system. Although these varied demands for power can be met to a limited extent by the main propulsion power plant, the concept of an independent and separated accessory power supply has evolved over a period of years.

The steering function, for example, has been studied in terms of utilization of the main power plant, and it was found that a considerable degree of complexity would be required. A few of the difficulties encountered are: Guidance power is available only after launching, and power frequently is not available for the entire flight; particularly with solid propellants, fuel is expended before the flight terminates; and increased weight and servomechanism complexity are introduced when using a power source with a large dynamic range, i.e., the range of a ballistic missile. For these and other reasons, accessory power units have been developed and tested.

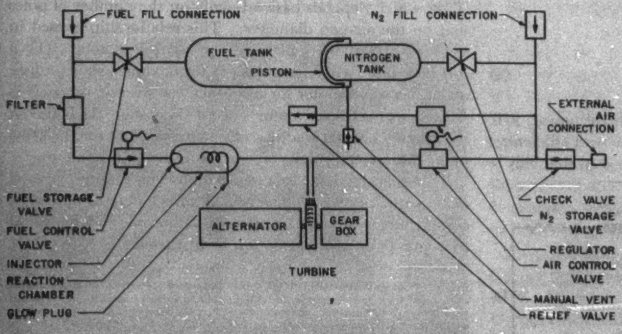

Fig. 1. Hot-gas turbine-driven power supply

DYNAMIC- VS STATIC-TYPE POWER SUPPLIES

ACCESSORY POWER SUPPLIES can be either static or dynamic in type. The static-type device utilizes batteries and accumulators to store and supply electric and hydraulic energy. The dynamic type utilizes rotating-shaft power to drive electric and hydraulic machinery. Early missile developments employed the static-type device to provide accessory power, and such systems were and are inherently reliable. However, static units are relatively large and heavy; field handling and storage problems detract from their use. In the tactical version of a missile, a device is required which has minimal weight and volume, possesses a long shelf life, requires a minimum amount of field handling, and does not require preflight adjustments. The optimum system is an electric or hydraulic unit operating from a concentrated energy source. The prime prerequisites are that this energy source must be:

1. Logistically expedient.
2. Safe to handle and store.
3. Amenable to a demand-energy rate.
4. Small in weight and volume.

A compact concentrated energy source that fulfills these requirements, i.e., logistics, storage, energy on demand, and minimum weight and volume, is a liquid-propellant system. In application, the stored chemical energy of the liquid propellant is released as high-pressure gas at moderate temperatures. The gas is expanded and directed against a turbine wheel, converting velocity energy to rotating-shaft power. This rotary power can be used directly for a mechanical servo, or it can be further transformed and used to drive electric or hydraulic apparatus. In simpler versions, the generated gas can be used directly as a source of energy without transformation in a turbine.

The hot-gas working fluid can be provided either by a liquid propellant or a solid propellant. The liquid-propellant system, usually monopropellant, offers a number of advantages over a solid-propellant system: (1) Power to the turbine can be controlled as a function of demand

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Full text of a District paper presented at the AIEE Middle Eastern District Meeting, Columbus, Ohio, May 4–6, 1955, and recommended for publication by the AIEE Committee on Air Transportation.

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power by fuel flow rate control. (2) Control can be accomplished by a nondissipative servo system. (3) Multiple-starting is possible with a liquid system, whereas the solid system is not amenable to start–stop operation. Multiple starts are advantageous for missile periodic check-out, system assembly checks, and multiple passes at the target.

For the solid propellant, either a hot-gas valve must be used or the excess power must be dissipated into a mechanical or electric speed-sensitive load. For the temperature ranges involved, approximately two-to-five times rated power must be dissipated by a solid-propellant regulator.

OPERATION OF THE PRIME-MOVER SYSTEM

A SCHEMATIC DIAGRAM of a typical hot-gas turbine-driven power supply, developed by the American Machine and Foundry Company (AMF), is shown in Fig. 1. The missile is placed in a "ready" condition by operating the nitrogen and fuel-storage valve. Prior to operation, the reaction chamber is "armed" by a glow-plug heating element for approximately 30 seconds. (For special applications, instantaneous "arming" can be accomplished with a squib, or by a spark ignition system employing compressed air or oxygen.) To initiate operation, external electric power is supplied to the fuel-control valve. The regulated compressed nitrogen pressurizes the piston of a positive-displacement tank, forcing the high-pressure fuel through the control valve, and then into the heated chamber. The application of heat (approximately 1,000 F, in the case of ethylene oxide) to the propellant continuously decomposes the fuel, changing its state to a high-pressure high-temperature gas. The gas is expanded through a nozzle and impinges upon the impulse-turbine buckets, thus providing shaft rotary power.

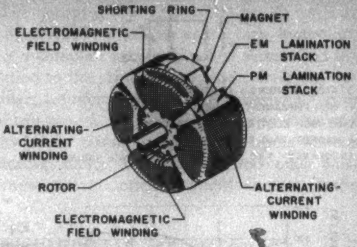
SHORTING RING
MAGNET
ELECTROMAGNETIC FIELD WINDING
EM LAMINATION STACK
PM LAMINATION STACK
ALTERNATING-CURRENT WINDING
ROTOR
ALTERNATING-CURRENT WINDING
ELECTROMAGNETIC FIELD WINDING

Fig. 2. Composite electromagnet and permanent-magnet high-frequency generator

The fuel control valve is activated either by a mechanical-centrifugal mechanism, or by an electric-frequency signal at low-power levels from associated electric apparatus. Operation continues at regulated speed until the fuel is expended. Typical operating periods are from 15 seconds to 30 minutes.

To refuel the system, the vent valve is depressed, releasing the positive force on the fuel piston. The fuel is injected through the fill-connection, fuel-storage valve, and into the

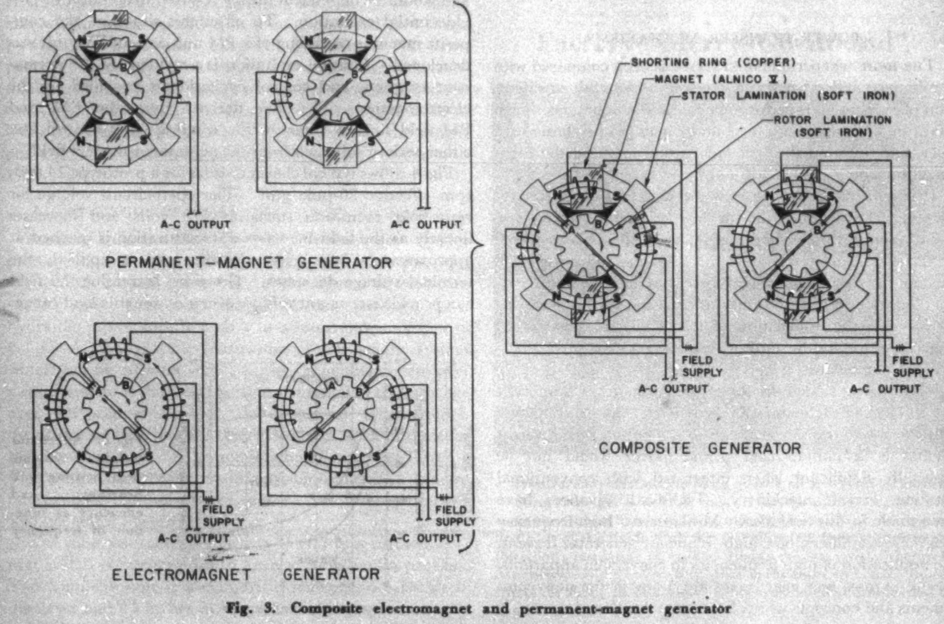
N
S
A
B
A-C OUTPUT
A-C OUTPUT
PERMANENT–MAGNET GENERATOR
FIELD SUPPLY
A-C OUTPUT
FIELD SUPPLY
A-C OUTPUT
ELECTROMAGNET GENERATOR
SHORTING RING (COPPER)
MAGNET (ALNICO V)
STATOR LAMINATION (SOFT IRON)
ROTOR LAMINATION (SOFT IRON)
FIELD SUPPLY
A-C OUTPUT
FIELD SUPPLY
A-C OUTPUT
COMPOSITE GENERATOR

Fig. 3. Composite electromagnet and permanent-magnet generator

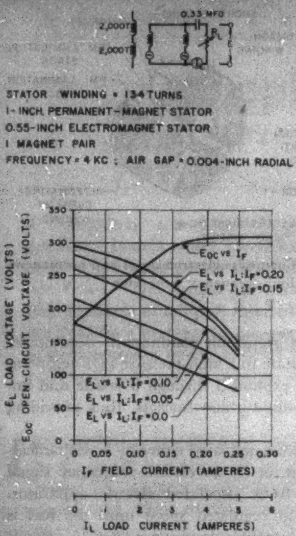

Fig. 4. A 750-watt 4-kc composite electromagnet and permanent-magnet alternator

tank. After the piston reseats, the fuel-storage valve is closed and the fuel line removed from the fill connection. The nitrogen vent is then resealed. The nitrogen is replenished in a similar manner through the nitrogen fill connection.

POWER-TRANSFER MECHANISMS

THE HIGH-SPEED TURBINE SYSTEM has been compared with the battery and other static devices. A careful consideration of existing high-performance power supplies has shown that, on a horsepower per pound versus energy basis with operating times on the order of 1 to 30 minutes, the high-speed turbine system is optimum.

It is interesting to note that the specific horsepower increases as a function of the turbine peripheral velocity and is optimum, for the turbine size and gas velocity considered, at approximately 60,000 rpm. Factors affecting safe turbine speeds are centrifugal force, bearing life, and windage and friction losses. The principal speed consideration, however, is the application of this device to gear boxes, generators, hydraulic pumps, and other associated shaft-driven components.

With respect to high-frequency components, it is interesting to observe the compatibility between the prime mover and the power-transfer mechanism. The space and weight savings of a miniaturized prime mover would not be especially significant when integrated with conventional rotating aircraft machinery. Technical advances have been made in this field also. Miniaturized high-frequency magnetic amplifiers, new high-frequency generator designs, the application of high frequencies to conversion apparatus, special pumps, and gear boxes are a few of the new components and concepts which have been developed.

To meet the requirement for small high-speed conversion devices, the turbo engineering department of AMF has developed a line of unique electric generators operating at shaft speeds ranging from 24,000 to 60,000 rpm. These machines are of the composite type—electromagnet (EM) and permanent-magnet (PM). In operation, these machines are similar to the inductor alternator because the flux change is dependent on the air-gap reluctance. The main advantage, however, is that complete flux reversal occurs. This flux reversal provides twice the flux change relative to the theoretical inductor alternator, where the flux is merely modulated. For an equivalent example, the flux-commutation variable-reluctance machine provides four times the power. This machine does not contain a rotating magnet, rotating coils, or slip rings. The rotor is made of a stack of notched round punchings of conventional electrical steel. The stator contains the a-c winding, permanent magnets, and, for certain applications, the field windings.

Fig. 2 illustrates the operation and configuration of this composite EM–PM machine, and Fig. 3 shows schematically the modes of operation. It will be noted that, as the rotor turns, the flux is provided in sequence from the field magnets for each stator winding. The flux polarity reverses, depending on the mated rotor and stator teeth.

For special applications, where close voltage tolerances must be held as a function of load and frequency and a PM machine is not suitable, the EM machine can be used. In this case, field excitation is provided by a magnetic-amplifier servomechanism. Operation in this self-excited mode, however, would require a "boot strap" technique and would be dependent on the residual magnetism to provide initial excitation. To offset this situation, the composite machine consisting of a PM unit and an EM unit was developed. Positive excitation is provided by the permanent magnets, and control excitation is provided by the electromagnets. The flux derived from the EM and PM field links a common a-c winding; the control flux either adds or subtracts from the permanent-magnet field.

Fig. 4 shows typical characteristics for a prototype 24,000-rpm effective 20-pole unit. The open-circuit voltage for zero field excitation starts at 178 volts and increases linearly as the field increases until saturation is reached at approximately 300 volts. As the load is applied, the terminal voltage decreases. However, increasing the field can provide a constant voltage over a reasonable load range.

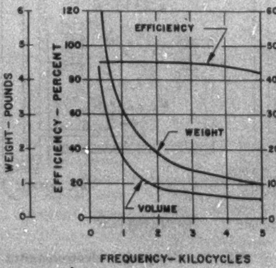

Fig. 5. Alternator weight, volume (less housing and bearings), and efficiency as function of frequency

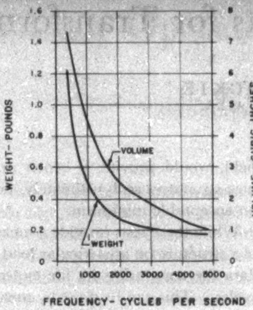

Fig. 6. Transformer weight and volume as a function of frequency (400-volt-ampere transformer, 1-minute operation)

The maximum output power for this regulated machine is approximately 0.75 kw for a 1.5-inch lamination stack.

Another specially designed machine is a 24,000-rpm synchronous motor. This machine serves a dual purpose, i.e., it furnishes the required run-up power prior to initiating the monofuel system, and functions as a 400-cycles-per-second (cps) generator after the turbine provides the drive torque. A 3-hp machine with a rotor 2.25 inches in diameter and 2.25-inches long has been designed to accomplish this task. Special techniques were applied to retain the field windings, and exotic cobalt steels were used to ensure the success of this miniaturized machine.

It should be emphasized that a considerable weight and volume savings can be attained by the use of high-frequency equipment. Magnetic components such as generators, transformers, filters, and chokes are reduced in volume and weight when operating at 4 kc as opposed to 400 cps by a factor of 6, at least. Magnetic amplifiers at 4 kc compete very favorably on a weight and volume bases with subminiature tubes. The time constant for these amplifiers is easily reduced without the necessity for the application of half-cycle response amplifiers. Curves showing the weight and volume reduction for various components are shown in Figs. 5 and 6.

LIGHTWEIGHT SPACE-SAVING POWER PACKAGES

Typical gas-turbine power supplies, now under production or development by AMF, range in output from 0.5 to 60.0 hp and operate at turbine speeds of 24,000 to 48,000 rpm. One unit, a 40,000-rpm package, is a hydraulic power supply with a maximum power output of 6 hp. A very graphic illustration of the weight savings which can be effected with a hot-gas machine system over a static system is the 3-to-1 weight reduction in this package over the original air blow down system. Furthermore, the operating time has been increased by a factor of three for the monofuel unit. A magnetic amplifier powered from a 40,000-rpm flux-commutation variable-reluctance generator regulates the fuel-control valve. The turbine bearings and generator operate at 500 F.

The most advanced design is a 48,000-rpm prime-mover unit which is integrated into an electrohydraulic package. The complete unit is a cylindrical package, 6.5 inches in diameter and 13 inches in length, weighing approximately 13 pounds. The output is 750 watts at 4.8 kc, 30 watts at 400 cps, and 1 hp at 2,000 pounds per square inch, hydraulic. This package is a complete accessory power system and includes, in addition to the prime mover, the conversion apparatus—rectifiers, transformers, and filters to derive B^+ from the 4.8-kc electric power, a 4-to-1 gear box to drive the miniaturized hydraulic piston pump and the 4-pole 400-cps machine, hydraulic pump, relief valves, and other miscellaneous components for operation and control of the system.

HIGHLIGHTS OF THE SYSTEM

The highlights of the hot-gas turbine-driven power supply are reviewed in the following:

1. The system is insensitive to missile attitude, acceleration, and vibration.
2. The system is capable of operating safely from −65 to +350 F; actually, the fuel is safe to temperatures approaching the autodecomposition temperature of 1,050 F.
3. Fuel control can be accomplished on a cold substance and does not involve hot-gas high-temperature valves, or excessively large conversion apparatus to handle the parasitic loads.
4. The system is safe and is not subject to explosive pressure surges from malfunction.
5. With proper valving, the system can be stored for indefinite periods.
6. The unit can be operated by unskilled personnel.

Factory "Merry-Go-Round"

Transformers destined to hang quietly on power poles all their working lives get a ride on this "merry-go-round" before they leave the General Electric Company, Pittsfield, Mass. During the first part of the "ride," all air is exhausted from transformers; this allows insulating oil, added during the last part of the cycle, to penetrate and fill every tiny space in the cores and coils. Round trip takes about 20 minutes. Units are loaded and unloaded by hand crane.

Life-Expectancy Tests for Transformers

A. M. LOCKIE
MEMBER AIEE

HEAVIER LOADING of distribution transformers offers significant operating economies, but it seems unwise to increase loading substantially without a realistic appraisal of its probable effect on life expectancy. Also, the development of new insulating systems offers potential economies, but the magnitude of the savings cannot be determined until the relative life expectancy of the new systems is determined.

These and similar problems indicate the need for a standard method of rating transformers in terms of life expectancy, as well as for a means of interpreting this rating in terms of anticipated load cycles in service. The best means of obtaining the necessary life-expectancy data is through some form of functional testing, which will require the establishment of an accelerated-aging procedure and a test to determine when the nominal end point of life has been reached.

As a starting point, it is suggested that the basic life-expectancy test consist of daily loading at 300 per cent of rating for 1 hour, 150 per cent of rating for 7 hours, and no load for 17 hours. This loading is repeated for 5 days and followed by an end-point test, including short-circuit tests at 15 times normal current for 2 seconds, standard impulse tests, and dielectric and induced-potential tests at 65 per cent of the standard values for new apparatus. The combination of loading and end-point tests constitutes one aging cycle, and the nominal life expectancy of the tested structure is expressed as the number of these cycles endured before failure. It would not be practical, at this time, to specify the minimum number of cycles which a structure must endure in order to be classified as having normal life expectancy. Nevertheless, tests of this type, made on structures which have given satisfactory operation in the field, would provide a bench mark for the evaluation of new structures and, ultimately, permit the establishment of an acceptable minimum.

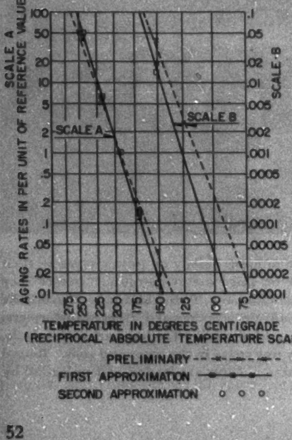

Fig. 1. Calculated aging rates

While these tests provide a measure of the life expectancy of a structure on a particular load cycle, they do not furnish data for computing its life expectancy on the other load cycles. This can be done by means of an aging-rate curve, which shows, as a function of temperature, the relative speed with which the structure reaches the selected end point of its life.[1]

The aging-rate data for a structure may be obtained by testing a number of samples, following the procedure used in the basic life-expectancy test, but using different values for the 1-hour load and measuring the winding temperatures throughout each different load cycle. A preliminary aging-rate curve may be selected, based on previous experience with similar structures or on tests made on the materials used in the structure. For each load cycle in which the winding temperatures are measured, a curve of the corresponding preliminary aging rates may then be drawn. For each different cycle, if the highest recorded temperature was maintained continuously, the total equivalent aging time to failure may be computed by multiplying the area under the curve of aging rates for that cycle by the number of cycles to failure, and dividing by the preliminary aging rate at the peak temperature.[1]

The ratio of the total equivalent aging time on each cycle to that for the basic test cycle will be an approximate aging rate for the cycle, corresponding to its peak temperature; these rates will establish an approximate aging-rate curve for the tested structure. Closer approximations may be obtained by repeating the procedure, using the newly established rates instead of the preliminary rates. The results of such a series of approximations are shown in Fig. 1.

Having the basic life expectancy and the aging-rate curve for a given structure, it is quite easy to solve various loading problems, such as the determination of life expectancy on any given load cycle, the steady load equivalent to a given cyclic load, or the cumulative aging effect of different cyclic loads. Thus, the procedures provide both a means of determining the relative life expectancy of different structures and a method of computing the effect on life expectancy of various forms of loading. Standardized procedures following these general lines should assist greatly in the evaluation of new insulation systems and in the more economical utilization of distribution transformers.

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High-Frequency Operation of Magnetic Amplifiers

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RECENT IMPROVEMENTS in frequency-multiplier techniques and the development of a simple transistor inverter have made possible high-frequency power supplies which have ruggedness and reliability commensurate with that of magnetic amplifiers. Consequently, it becomes practical to operate magnetic amplifiers at frequencies above the readily available 60- or 400-cycle power supplies. The possibility exists of making magnetic amplifiers with shorter response times, smaller size, and greater power gain than presently attainable in the power frequency range. At high frequencies it is possible to control a given voltage with fewer load turns or with much smaller cores. From the standpoint of keeping amplifier exciting currents small, it is desirable to keep the number of load turns reasonably large. The equation defining the power required to drive the amplifier from cutoff to full output gives an even more important reason for keeping the number of load turns relatively high and reducing the iron cross-sectional area at higher frequencies.

$$P_c = 0.715\,\frac{B_m l_m E_s}{T\mu_d N_L}$$

B_m = saturation flux density
E_s = supply voltage
l_m = mean circumference of core (cm)
N_L = number of load turns
P_c = power for full control
T = response time in cycles
μ_d = differential permeability

The equation states that, for a given response time and core material, the control power will be minimized if the supply voltage is supported by a large number of load turns and a correspondingly small iron cross-sectional area.

A limit on the number of turns is set by the allowable internal impedance of the saturated amplifier. At power frequencies the internal impedance at saturation of the amplifier results almost entirely from the resistance of the load winding. In contrast, at frequencies above the audio range the internal impedance of a practical amplifier core is determined almost entirely by the saturated reactance of the load winding, and the effect of its resistance is negligible. Considering the reactive nature of the saturated impedance, the figure of merit *m* of a high-frequency amplifier can be expressed in terms of the design variables.

$$m = 1.12\,\frac{E_s \mu_d N_L}{R_L B_m l_m}\left[\frac{1}{1+\frac{X_s^2}{R_L^2}}\right]$$

m = power gain per cycle response
R_L = load resistance
X_s = saturated reactance of amplifier

The figure of merit for an amplifier of a given output power and core material is a function of X_s/R_L. Differentiation of this equation shows that the figure of merit is maximized when the amplifier is designed so that the saturated reactance of the amplifier equals $\sqrt{3}$ times the load resistance.

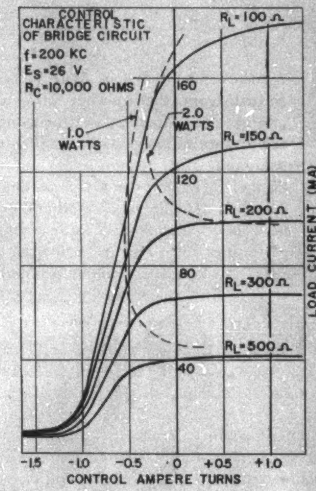

Fig. 1. Set of transfer curves for 200-kc magnetic amplifier bridge circuit

At high frequencies the differential permeability of even the best ultrathin magnetic core materials is low relative to the permeabilities obtainable in the power-frequency range. Nevertheless, high-frequency amplifier operation can yield much higher amplifier performance because of the advantage of controlling a given power with much smaller cores. To demonstrate this advantage, a one-stage amplifier operating at a supply frequency of 200 kc and delivering 2.0 watts to a 150-ohm load has been designed. A set of transfer curves for the amplifier is given in Fig. 1. The stage has a measured power gain per cycle of response time of 100 and a power-gain-per-second response of 20×10^6.

The advantage of high-frequency operation is made most clear by noting that the use of full-wave circuitry makes it possible to trade response time for power gain and achieve high-power gains, yet retain reasonably short response times. This feature of the amplifier is best expressed by the value of the power-gain-per-second response (20×10^6) which is at least two orders of magnitude greater than normally encountered with a 60-cycle amplifier of comparable power output. As a result, high-frequency operation of magnetic amplifiers makes possible power gains and bandwidths unattainable in the power-frequency range.

Digest of paper 55-465, "High-Frequency Operation of Self-Saturating Magnetic Amplifiers," recommended by the AIEE Committee on Magnetic Amplifiers and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Published in AIEE *Communication and Electronics*, September 1955, pp. 500–05.

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Development of an Interchangeable-Engine Generator Set

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At the end of World War II, the need for reduction in the number of general-purpose engine generators, as well as associated equipment, for military requirements was evident. Assigned the responsibility of solving the difficult problem, the Corps of Engineers, U. S. Army, is developing a family of generator sets in which the 30-kw interchangeable-engine generator set presents a logical approach to one of the major problems.

TWO DEVELOPMENT PROJECTS of general interest at the Engineer Research and Development Laboratories, Corps of Engineers, U. S. Army, Fort Belvoir, Va., are: development of a family of general-purpose generator sets for military requirements; and development of a Qualified Products List (QPL) of industrial-type gasoline engines suitable for use as prime movers in military equipment and incorporating military standard parts. The development of the 30-kw interchangeable engine generator is an attempt to integrate these two projects, so that a generator set of this kilowatt rating will accept all of the engines on the QPL of appropriate horsepower rating.

BACKGROUND

AT THE OUTBREAK of World War II, in order to obtain the large number of generator sets needed to support the widespread activities of our fighting forces, it was necessary to buy engine generators in an almost endless variety of makes and models. As a result, an incredible number of different sets saw service in the field. One technical service alone had more than 350 different sets in ratings of 100 watts to 300 kw, and as many as 15 sets of approximately the same kilowatt rating. One set was built in modifications which ran through the alphabet and up to *AE*.

At the end of the war, each technical service reviewed sets which it had procured. This led to a reduction of the number of different sets considered necessary to 252; but still left much duplication of sizes. For example, 73 sets were considered necessary to cover the requirements for sets rated 0.7 to 9 kw, and most of these were for single-phase 60-cycle current.

Table I. Length and Width of Commonly Used Generators and QPL Gasoline Engines

Unit	Length, Inches	Width, Inches
Generator		
X	36	$21\frac{3}{4}$
Y	$32\frac{3}{4}$	$21\frac{3}{4}$
Z	$26\frac{3}{4}$	$21\frac{3}{4}$
Engine		
A	$31\frac{3}{4}$	$31\frac{1}{8}$
B	46	$27\frac{1}{4}$
C	42	$25\frac{3}{4}$
D	39	$18\frac{1}{4}$

The need for a drastic reduction in the number of sets in use and under development led the U. S. Army to undertake a study on the desirability of assigning responsibility for general-purpose engine generators to a single technical service. Late in 1947, the Corps of Engineers was assigned the responsibility for "Research and development, computation of requirements, provisions of funds, specifications, purchase and inspection, storage and issue, and maintenance of all general-purpose engine generators for the entire Army."

Reviews by the Corps of Engineers of the stated power requirements of the technical services showed many small differences, such as: 300 and 350 watts; 500 and 600 watts; 1.25, 1.30, and 1.5 kw; 2.0, 2.4, and 2.5 kw; and 7.5 and 8.0 kw. Careful analysis as to power requirements and other characteristics resulted in the establishment of a family of 43 engine generators currently under development at Engineers Research and Development Laboratories.

Similar problems resulted from the use of more than 340 different makes and models of engines during World War II. Study of this situation resulted in the subsequent assignment to the Corps of Engineers of responsibility for the standardization of industrial engines for military use. This standardization program carried on in co-operation with the engine industry has resulted in the reduction to 165 military standard parts the 1,827 formerly required to support gasoline engines within the $2\frac{1}{8}$- through 6-inch cylinder-bore range. The greatest reduction was achieved in the most popular bore sizes, 3 through 4 inches. High-mortality parts to support the 138 engine models manufactured in this size range were reduced from 1,187 different noninterchangeable parts to 59 interchangeable parts. Noteworthy reductions were achieved in the other bore ranges as well. A program to standardize engine accessories is also in progress.

QPL of commercial engines successfully modified to incorporate the standard parts has been established, and thousands of engines have been procured. Although the QPL engines now utilize standardized high-mortality parts and will later include standardized accessories, they are largely commercial engines and vary in the number of cylinders, cylinder arrangement, and other vital details. Since every effort is being made to utilize fully the produc-

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A special article recommended for publication by the AIEE Committee on Power Generation.

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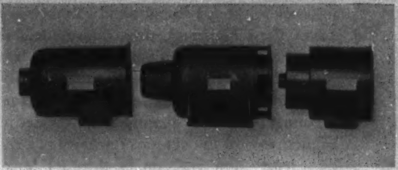


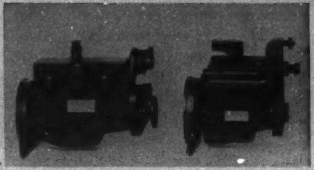


Fig. 1 (right). Thirty-kilowatt interchangeable-engine generators, showing comparative sizes of commercial models, X, Y, and Z. Fig. 2 (far right). Thirty-kilowatt interchangeable-engine generators, showing comparable sizes of commercial engines, B and A

tion potential of the industry, additional makes and models will be added periodically.

It is therefore expected that space requirements and other characteristics of engines for a generator set of a given rated output will vary widely, and will adversely affect the possibility of substituting one engine for another in the conventional generator set. Recognition of this condition has led to the establishment of a project for the development of a 30-kw interchangeable engine generator set.

CURRENT STUDY

The 30-kw rating was selected largely because it represents a widely used size in both 60- and 400-cycle constructions, and because of greater possible differences in the dimensions of its major components (Table I).

Determinations were based on the general design of an engine generator rated 30 kw, 0.8 power factor, 120/208–240/416 volt, 3 phase, 4 wire, 60 cycle; convertible to 25 kw, 0.8 power factor, 240/416 volt, 3 phase, 4 wire, 50 cycle; or to 30 kw, 0.8 power factor, 120 volt, 3 phase, 3 wire, 60 cycle.

The initial phase of the work was an evaluation of problems incidental to the development of a set in which any one of the engines listed in Table I could be installed interchangeably with the generator selected because it had the greatest over-all length of those in common use, and a design encompassing other shorter generators. Major consideration was given to development of the following:

1. A common connection of the generators and engines, with emphasis on the problem of synchronous torsional vibration and on the possibility of developing a method of reducing the interchange of heat between engine and generator.
2. A fuel system; coolant system, including radiator and pump; lubrication system; and exhaust system suitable for all military conditions.
3. A winterization system suitable for use in Vee and In-line engines.
4. A single design of panel and control cabinet for all four combinations, including lessons learned by other technical services in quick identification of instruments and meters by operating personnel.
5. A combination of skid-base and housings to properly support and house the components in all constructions.

CONNECTION OF THE MAJOR COMPONENTS

The first approach to the connection of the generators and engines involved the replacement of conventional flywheel housings with a drive of novel design. The drive consisted of flywheels made for each engine, but having a common ring gear and a flexible coupling of the pneumatic type between the shafts. The surrounding flywheel housing carried the starting motor, magneto, battery-charging generator, and governor. All were driven through a train of gears by the ring gear on the flywheel.

It was planned to make this accessory drive a permanent part of the set. Different generators could be attached directly to one end; at the other end, engines could be attached through an adapter based on the individual engine cylinder block.

The accessory-drive concept seemed to present a simple approach to the interchangeability requirement, but several serious disadvantages appeared as the design was detailed. The situation may be summarized as follows:

1. *Advantages:* One set of permanently installed engine accessories could be used for all of the engines to reduce material and labor cost during replacement of different engines. Shorter and simpler governor linkage could be used to assure more accurate speed control. All electric connections, except those for the ignition harness, could be permanently installed. Accessory drive housing would be the central anchorage with thermal expansion limited to shorter lengths to each side.
2. *Disadvantages:* The *V-8* engine still required a different magneto. Any practical disposition of the accessories would lead to a ring gear of large diameter, having high pitch-line speed; this would require very well-made gears and special care in the initial alignment and during subsequent maintenance work. Repeated engagement of the starter would produce irregular wear and adversely affect the fine backlash required for reasonably quiet operation. The accessory drive would introduce a space of more than 8 inches between the cylinder block and generator coupling flange, which seemed to be an excessive amount of space for a connection having so few advantages. Replacement of the ring gear with a belt drive would reduce the noise, but it would require a belt about 3-inches wide and introduce new problems of longer space requirement and maintenance of belt tightness. Investigation developed that the material, now used to make this coupling is not suitable for –65 F service.

Since the approach to a new type of connection of the generator and engine was so unfruitful, more conventional constructions were studied. These included a Society of Automotive Engineers' (SAE) standard flywheel housing and clutch flywheel, a close-coupled construction currently in use, and an intermediate design which was finally adopted. Essential considerations were as follows:

1. SAE standards for flywheel housings establish dimensions of the connecting housing and clutch flywheel flanges,

where the power is taken off. The latter flange is then located only in relation to the flange on the end of the crankshaft. Inasmuch as the position of the crankshaft flange in relation to the cylinder block varies with each engine design, the length of the housing also varies but seldom exceeds $4^{1}/_{2}$ inches. The adapter used to connect the generator to the engine flywheel housing is designed to discharge the cooling air from the engine and adds at least 3 inches, even where access to the connecting coupling is limited to an opening about 2-inches wide.

2. Some 30-kw sets are now being built in a close-coupled construction without the conventional flywheel housing. The generator adapter combines the most essential requirements of both parts and, when used with a special flywheel, reduces the total length requirement to about 3 inches. Access to the coupling for connection and checking of alignment is very limited. The use of such construction was considered to be undesirable for this development inasmuch as improved access for interchanging engines is a primary requirement.

3. The design developed for this set is based on the utilization of the better characteristics of both of the foregoing constructions. The length of the SAE flywheel housing has been reduced approximately $1^{1}/_{2}$ inches without interfering with the electric starter and the temporary support arrangements. This length was then added to the width of the access opening in the generator adapter. The opening to the parts connecting the engine shaft and generator shaft is increased to $3^{1}/_{2}$ inches without appreciable deviation from SAE flywheel housing (Figs. 1 and 2).

The flow of heat by conduction through the flywheel housing and coupling into the generator will be kept to a minimum by the system of controlled air flow through the housing. With this construction, it has been determined that the relative movement of the rotor in relation to the stator under the most adverse conditions will not exceed one third of that permitted by the generator bearing design.

ACCESSORIES

Fuel Tank. The general-purpose engine generators currently under development are required to be portable. This is interpreted as meaning a self-contained construction, which may be set on reasonably flat ground or mounted on a trailer. These alternatives seriously affect the design of the fuel storage system. A 5-gallon military gasoline can may be used to fill a fuel tank with the filler cap about 5-feet high and, thus, permits a high mounting of the fuel tank. This position is preferred by many because of somewhat easier tank replacement. However, such construction has serious disadvantages when the set is trailer mounted.

The dynamics of wheeled equipment makes the height of the center of gravity of prime importance and justifies a low position of the fuel tank (in the skid), even though replacement may be a little more difficult. Since other considerations had led to the use of deep channels as skids, it was decided to mount the fuel tank under the engines. This tank will be carried in steel straps, lined with vibration absorbent material, and will be removable from the top or bottom.

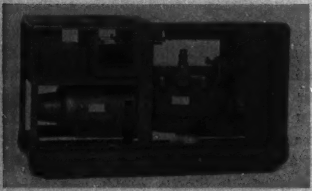
Radiator. It was originally planned to use a circular finned-tube radiator utilizing a belted sirocco-type blower driven from the generator end, but it did not fit very well into the geometry of the set and failed to permit the development of the most effective air flow through the set. It was therefore decided to work with a more conventional radiator for the dissipation of 160,000 Btu per hour in the coolant with air which has already absorbed 120,000 Btu per hour as radiated by the engine.

The use of the radiator on the forward end of the engines resulted in an unusual fan-drive design. As shown in Table I, a difference of more than 14 inches exists in the length of the engines. There is also a difference of 5 inches in the distance from the centerline of the crankshafts to the centerline of the fans. This made the use of the fans now on the engines impractical because of the unwieldy shrouding.

It was decided that the most practical construction would consist of a unit fan drive built into the radiator housing. All fans will be removed from the engines and connection to the fan-driving sheave will be made with short flanged shafts of appropriate lengths (Figs. 3 and 4).

Cooling Air Flow. The method of controlling the air flow through the set has been developed so that the set may be operated with the side covers of the housing closed. Work done at the Laboratories' Arctic Test Station at Fort Churchill, Manitoba, Canada, and the Arizona Desert Test Station, Yuma, Ariz., has indicated that such operation is desirable as a method of limiting the entrance of snow, sand, and snakes.

The interior of the set is divided into a generator compartment and an engine compartment by a baffle built into the central A-frame. Both compartments have air control doors at each end. Under low ambient conditions, all doors are to be closed except those on the front end of the engine compartment. Under normal ambient conditions, the doors at the end of the generator compartment and at the flywheel end of the engine compartment are to be opened. Under high ambient condi-



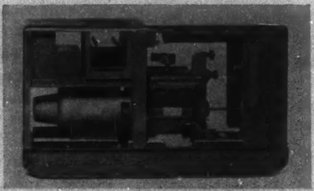


Fig. 3 (left). Thirty-kilowatt interchangeable-engine generator (right side), showing X and B assembly. Fig. 4 (right). Thirty-kilowatt interchangeable engine generator (right side), showing X and A assembly

tions, all doors are to be opened. Recirculation of air in the housings at the lower ambient conditions is expected to produce better performance, while the directed flow of air is expected to produce cooling running at the higher ambient conditions.

Lubrication System. The lubrication systems of the engines are being left intact. Heat normally rejected to the atmosphere will be radiated into the housing and out through the radiator. This system is expected to be adequate, but it can be readily supplemented with a small finned-tube heat exchanger if this arrangement does not prove to be satisfactory in tests.

Exhaust Muffler. A single exhaust muffler will be used for all of the engines, since this can be done with little or no adverse effects on the "tuning" of the system. A length of flexible tubing will be attached to the engine side of the muffler, which is supported in the top of the housing. Adjustments to a wide variation in the locations of the various exhaust-manifold flanges will be accomplished by the use of a short piece of formed tubing which connects each engine to the flexible tube.

Winterization. The basic element in winterization systems of engine generators is the small vertical or horizontal heater usually mounted to one side of the engine, where either the heater or starting batteries are installed. The width and configuration of one engine type made such a location impractical. A horizontal heater was then selected and set into the alternative position under the radiator. It became necessary to use connecting piping of different lengths to correct for the different positions of the coolant connections on the various engines.

Electrical Controls and Connections. The use of only one generator for the first set simplified the control panel and the electric connections. However, the placement of meters, indicator lights, and switches was determined so that they could be in the same relative position for 400-cycle sets, as well as for these 60-cycle sets. It might also be noted that the power take-off terminal posts are located in a protected position at the back end of the set, and all power connectors and convenience outlets have screw-on caps or snap covers, which are so arranged that power cables can be connected with all the doors and covers closed.

Base and Housing. Wide differences in the vertical and horizontal locations of the engine mountings resulted in the incorporation of "tracks" into the skid-base channels, so the two "bridges" supporting the engine can be slid to the position required by each engine (by careful design work only two positions are required for the four engines as shown in Fig. 5). The entire base and housing structure was studied on the bases of being rolled off the tail end of a truck and of being jerked to 5 g while swinging on a single hook.

EASE OF MAINTENANCE

Consideration has been given to ease of maintenance throughout the study and development phases. This has led to the use of quick-disconnecting pipe couplings and airplane-type fasteners where needed. It has also led to constructions, which allow for ready movement of large masses of the structure, such as:

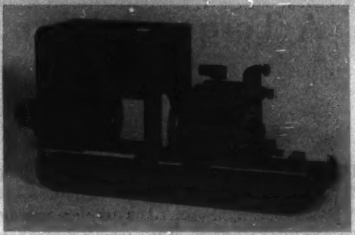


Fig. 5. Thirty-kilowatt interchangeable-engine generator (right side), showing separation of engine and generator

1. Access to generator brushes is usually obtained through the side covers and through the back end of the set. Such access is available in this construction, but it is also possible to draw back the generator until the exciter projects outside the set at the back end.
2. All electric leads passing into the control cabinet are connected at terminal strips, so that the cabinet can be removed and replaced as an entity without dangling wires.
3. The entire front end of the housing, including the radiator, fan, fan drive, fan shroud and guard, muffler, tailpipe, and other parts, can be swung away from the engine to provide improved access to all of its parts. Removal of the hinge pins at the bottom of the front end assembly readily permits complete removal of this assembly.
4. The sliding bridge under the front end of the engine provides a method of compensating for the various locations of the front end supports of the engines. In combination with the flywheel-end bridge, it provides a means for sliding the engine forward to simplify repair and replacement.
5. Batteries are accessible from the side and above.

This development may affect engineering maintenance procedures. It is expected that a seriously damaged engine will not tie up a generator set nor require its return to depot to await replacement by a specific make of engine. Any one of the interchangeable engines in the group may be used, and the installation can be done by a battalion maintenance section. The damaged engine can be sent back for the fourth echelon rebuilding if salvage is indicated.

PRESENT PLANS

The work done to date leads to the opinion that the construction of a 30-kw interchangeable engine-generator set is practicable. Construction has started on two basic units and on a set of installation components for each of four gasoline engines. After the interchangeability has been demonstrated, extended tests will be run on two complete sets having different commercial engines on the QPL.

It is imperative, therefore, to emphasize that it will be necessary to study the results of the contemplated tests and to try the plan on additional sizes before concluding that this design has started a trend in generator-set construction.

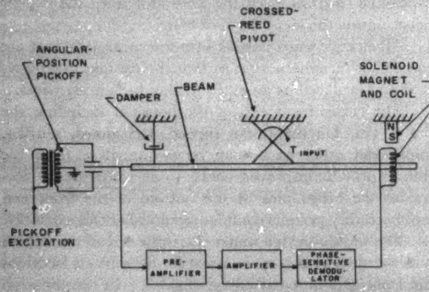
A Torque Balance for Precision Measurements

R. J. MATTHYS

A TORQUE BALANCE was developed for the purpose of measuring torque-motor stall torques in the range of 0.05 to 100,000 dyne-cm. The torques are measured at various angular positions of the torque-motor rotor with respect to the stator. In this torque range, the primary measurement problem is the friction in the pivots or bearings of the measuring instrument. Of the many pivot types tried, the crossed-reed pivot had the lowest friction level.

The torque balance is shown schematically in Fig. 1, and as a complete unit in Fig. 2. Its main parts are a rigid beam that rotates on a crossed-reed pivot, a capacitor-type position pickoff, an amplifier, and two permanent-magnet solenoids.

The balance, in principle, acts as an angular spring, with the pickoff, amplifier, and solenoids providing a torque proportional to angular beam displacement. When a torque is applied, the beam rotates from the null position to a position where the spring torque of the beam exactly counterbalances the applied torque. To minimize errors the angle of rotation is kept less than 0.004 degree.



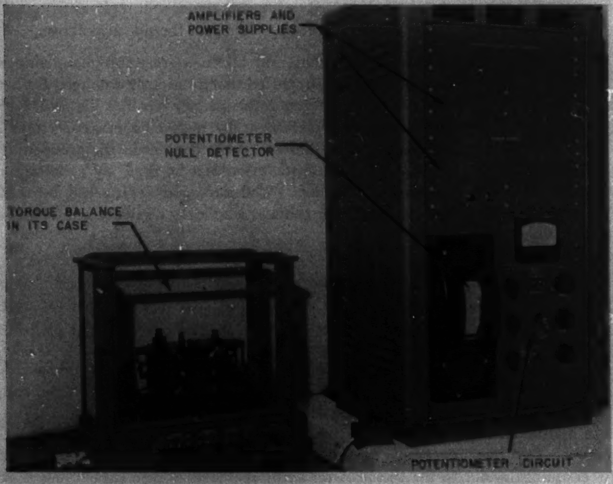

AMPLIFIERS AND POWER SUPPLIES
POTENTIOMETER NULL DETECTOR
TORQUE BALANCE IN ITS CASE
POTENTIOMETER CIRCUIT

Fig. 1 (above). Torque balance. Fig. 2 (below). Complete balance system

The capacitor-type position pickoff has a threshold of less than 3×10^{-9} radians. The friction level in the crossed-reed pivot is below the threshold of the balance. The spring stiffness of the crossed reeds is compensated to zero by increasing the load they support, so that the reeds operate at a point of zero stiffness. Two fluid damper dashpots are used on the beam to reduce vibration.

The balance is calibrated by applying a known torque to the balance. The known torque is an accurately known weight, which is placed in a weight pan hung from a knife edge at a known distance from the center of beam rotation.

The applied torque is measured electrically by measuring the current in the solenoid coils with a potentiometer circuit. Torques up to 1,000 dyne-cm are read from the potentiometer, which is calibrated directly in hundreds, tens, units, tenths, and hundredths of dyne-cm. Torques exceeding 1,000 dyne-cm are "balanced off" by weights and the remainder is read from the potentiometer.

As Fig. 1 shows, the amplifier and solenoids form a closed loop on the balance, having a natural frequency of 6 cps, a damping ratio of 2, and a loop gain of 60 db.

The over-all accuracy of the balance depends, primarily, on the accuracy of calibration and on the solenoid and potentiometer linearities and, secondarily, on the constancy of reed stiffness with rotation. All other errors are reduced to negligible proportions by the large spring stiffness of the beam (1.5×10^7 dyne-cm per radian). Accuracy of torque measurements made on the balance is 0.3 per cent, + 0.05 dyne-cm for the range of 0.05 to 2 dyne-cm; 0.3 per cent, + 0.1 dyne-cm for the range of 2 to 1,000 dyne-cm; and 0.1 per cent, + 15 dyne-cm for the range of 1,000 to 100,000 dyne-cm.

Digest of paper 55-486, "A Precision Torque Balance for the Measurement of Small Torques," recommended by the AIEE Committee on Instruments and Measurements and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Published in AIEE *Communication and Electronics*, September 1955, pp. 485–90.

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Power-System Representation on Network Analyzers

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MEMBER AIEE

W. J. CLOUES
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ONE OF THE MAJOR PROBLEMS encountered when an extensive power system is to be represented on an a-c network analyzer is that of developing proper equivalents for those portions of the power system which are not to be represented in detail.

Several methods are available currently for developing fairly satisfactory equivalents for load-flow studies.[1] There is no correspondingly satisfactory method available for developing an equivalent for stability studies where there are several points of interconnection between that portion of the system to be retained as real and that portion to be represented by an equivalent. Stability equivalents which have been used have not been identical in performance to load-flow equivalents. Modification of the analyzer setup has been necessary whenever it is desired to change from a system representation suitable for a load-flow study to a system representation suitable for a stability study.

For the past several years the Philadelphia Electric Company has used for a-c analyzer studies a new type equivalent which can be used interchangeably for load-flow and for stability studies. This combination load-flow and stability equivalent has been found to be particularly useful for a-c analyzer studies where load-flow studies are made concurrently with stability studies and where a portion of the system to be studied cannot be set up in detail.

This new equivalent is basically a load-flow equivalent which has been modified to include an equivalent generator having synchronizing power characteristics similar to those of an equivalent generator in a conventional stability equivalent. The performance of the new equivalent from a load-flow point of view is similar to that of a load-flow equivalent in which the transmission network of the system to be shown by an equivalent is represented by a mesh network having impedances equivalent to that of the actual transmission system, and where all generators and loads are reflected to the terminals of the equivalent by the use of distribution factors. The performance of the new equivalent with respect to its synchronizing power ability is similar to that of a conventional stability equivalent, which is developed on the assumption that all generator transient reactances in the system to be shown as an equivalent may be connected together.

Investigation of a hypothetical 2-company power system was made on an a-c network analyzer in order to test the validity of the proposed new equivalent. Studies were made with (1) both companies represented in detail, (2) Company *B* represented by a combination load-flow and stability equivalent, and (3) Company *B* represented by a conventional stability equivalent. Line loadings on the three tie lines between the two companies, tabulated for the various methods of representing Company *B* are:

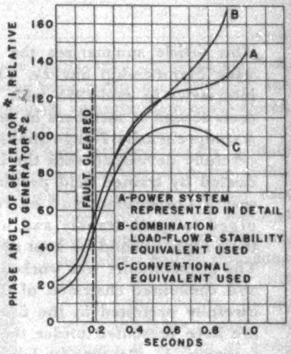

Fig. 1. Power-angle curves showing relative angles of the two generators in Company A

	Megawatt Flows on Tie Lines Between Company A and Company B		
	Line 1	**Line 2**	**Line 3**
Both companies represented in detail	66	36	36
Company *B* represented by a combination load-flow and stability equivalent	65	34	40
Company *B* represented by a conventional stability equivalent	27	38	74

Results of stability studies showing the relative angles of the two generators in Company *A* are plotted in Fig. 1.

Conclusions regarding the performance of the proposed combination load-flow and stability equivalent, when used to represent one company of this hypothetical 2-company power system, and conclusions regarding the performance of a more conventional stability equivalent, are as follows:

Load-Flow Studies. (1) Use of the combination load-flow and stability equivalent will give results almost identical to those obtained when the entire power system is represented in detail. (2) Use of the conventional stability equivalent will give results which are at marked variance with those obtained when the system is represented in detail.

Stability Studies. (1) Use of the combination load-flow and stability equivalent will give results which agree closely (showing, however, a slight tendency towards greater instability) with those obtained when the entire power system is represented in detail. (2) Use of the conventional stability equivalent may, in critical cases, lead to the conclusion that a system is stable when the system actually is unstable.

REFERENCE

1. Equivalent Circuits for Power-Flow Studies, J. B. Ward. AIEE *Transactions*, vol. 68, 1949, pp. 373–82.

Digest of paper 55-282, "Combination Load-Flow and Stability Equivalent for Power-System Representation on A-C Network Analyzers," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the Middle Eastern District Meeting, Columbus, Ohio, May 4–6, 1955. Published in AIEE *Power Apparatus and Systems*, August 1955, pp. 282–7.

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Members Appraise the AIEE

H. L. RUSCH
ASSOCIATE MEMBER AIEE[1]

W. D. RUGG
MEMBER AAPOR[2]

This article summarizes the scientific nation-wide Membership Survey, based on personal interviews in mid-1955 with a representative cross section of members in each AIEE district. A comprehensive 7-page questionnaire was very carefully developed with the interviewing conducted by trained field people of Opinion Research Corporation, and all respondents were urged to speak frankly and were assured that their replies would be kept strictly anonymous. The questionnaire was worked out with officers and committee chairmen of the Institute, and carefully pretested in the field. The findings are here presented under the following major sections: I. Reasons for Joining the AIEE and Benefits of Membership; II. Administration of the Institute; III. Meetings; IV. Publications.

REASONS FOR JOINING THE AIEE AND BENEFITS OF MEMBERSHIP

LOOKING FIRST at the objectives members had in mind when they first joined the AIEE, the chief mentions fall under the following major classifications: (1) the improvement of knowledge; (2) the prestige that is conferred by affiliation with a recognized professional society; (3) the improvement of the status of the profession and of its members; and (4) the opportunity to associate with other members of the profession. The success of any professional society depends on its ability to assess the relative importance of these several major interest to members and, accordingly, devote the proper attention to each. From the testimony, it appears that "improvement of knowledge" is the most important concern of members.

When asked: "What would you say were the main reasons you first joined the Institute?" the most frequent replies classify as follows:

	Per Cent
Improvement of knowledge	46
Prestige considerations	32
Association with other Engineers	28
Because other students did; professors encouraged it	23

(Percentages add to more than 100 because some members gave more than one reason)

The importance of student activities is indicated by the fact that 23 per cent of the members say they joined the AIEE because it was the thing to do in college or because their professors encouraged it.

When asked which Institute activities have proved most beneficial, members come up with answers which classify under the following major headings:

	Per Cent
Publications	57
Meetings	54
Associations with other Engineers	19
Technical-discussion groups	9
Committee work	4

(Percentages add to more than 100 because some members cited more than one activity)

As noted, publications and meetings are mentioned far more often than any other item as the chief benefits derived from Institute membership. Meetings, of course, serve both "knowledge" and "fellowship" objectives.

The next step was to try to ascertain the relative importance of two main Institute objectives by asking the respondents to make a direct choice, based on the following question:

> "In your opinion, to which of these two objectives should the Institute devote more attention:
>
> "The advancement and dissemination of engineer-knowledge
>
> OR
>
> "The improvement of the status and prestige of the electrical-engineering profession?"

The results are shown graphically in Chart 1, and are very

The officers of the Institute have felt for some time the need for a better understanding of the objectives for which the membership is looking. As Past-President A. C. Monteith pointed out in his address, "Let's Do More Planning Ahead," before the Southern District Meeting in St. Petersburg, Fla., the Institute is "big business," and in order to continue to grow, any organization must be keenly aware of the interests of its members. And as President M. D. Hooven emphasized in his address, "Solidarity of the Profession," at the last Fall General Meeting in Chicago, the Institute must work diligently for the advancement of the art and the progress of the profession, and an important factor in reaching these objectives is the attitude and the thinking of the membership. In any democratic society, the leadership must rely heavily on the constituents for wisdom and guidance in policy-making decisions.

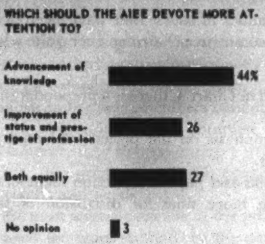
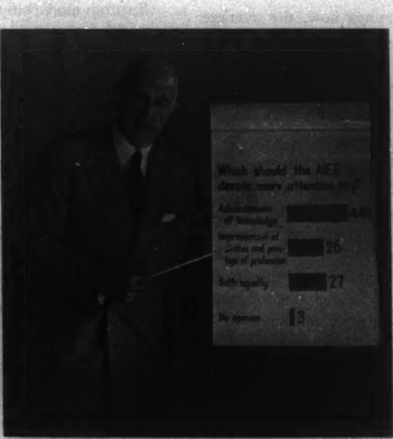


Chart 1

interesting in view of serious discussions among Institute leaders over many years.

This testimony does not mean that efforts to raise the prestige of the profession should be curtailed or abandoned. What it does suggest is that the advancement of knowledge is regarded by members as the foremost objective of the Institute and, therefore, should receive corresponding attention and emphasis.

At this point, it might be well to mention that a great many individual comments, as well as suggestions, were made by the respondents; all of these were recorded in the final report of the survey. From all indications, the members were most candid in their appraisals and did not hesitate to voice both praise and criticism of the Institute and its activities. But, of course, in arriving at policy-making decisions, the individual comments must not be given nearly the weight given the opinions of large cross sections of the membership; thus, this paper reports primarily these group opinions.


Which should the AIEE devote more attention to?
Advancement of knowledge
44
Improvement of status and prestige of profession
26
Both equally
27
No opinion
3

A chart presentation highlighting the results of the survey "Members Appraise the AIEE" was given at a meeting of officers and members of the Planning and Coordination Committee at Institute Headquarters by H. L. Rusch, of Opinion Research Corporation.

ADMINISTRATION OF THE INSTITUTE

TURNING NOW to the Administration of the Institute, members exhibit no substantial dissatisfaction with the way the Institute is run at the national level. There is only minority criticism of dues, election procedures, membership requirements, and that certain groups have too much power. However, minority dissatisfaction should not be overlooked, especially since as many as one fourth of the members are critical on certain points.

A key question was asked.

"If you had your way, would you make any changes in the way the national organization of the AIEE is run?"

The replies were as follows:

	Per Cent
Yes	25
No	55
No opinion	20

A great many members made very useful suggestions, all of which will be given very careful consideration; the verbatim comments compiled comprise four single-spaced typewritten $8^1/_2$- by 11-inch pages.

The feeling on the part of some members that the Institute is dominated by the power group may warrant further study. About one fourth of the members (26 per cent) say that some group has too much to say in running the Institute, and about half of this number—12 per cent of the total—cite the power group. While this is not a large percentage, it is twice as many as name any other group.

A substantial majority of members express satisfaction with the AIEE election procedures. Only 13 per cent say that they are not satisfied with the present method of nominating and electing officers, as noted in Chart 2.

When specifically asked: "What changes would you suggest?" the chief criticism of those who are dissatisfied is that there is "no choice of candidates." One verbatim comment in this connection is interesting:

> "It's hard to say. If you complain, you should know the cure. I don't know a better way off-hand I think it could be improved but I don't know how."

Large majorities of the members approve of the standards

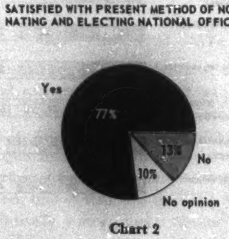


Chart 2

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[1] H. L. Rusch is vice president of Opinion Research Corporation, Princeton, N. J., and has been an Associate Member of the AIEE since 1923.

[2] W. D. Rugg is research director of Opinion Research Corporation, and a Member of American Association for Public Opinion Research.

and requirements for Associate Member and Member grades in the Institute. When asked whether the standards and requirements for these two grades of membership are too high, too low, or about right, 86 per cent testify that the Associate Member standards are about right, and 77 per cent that the Member standards are about right.

It is also of interest to note that a large majority of the members (71 per cent) say that membership dues are "about right."

Members apparently do not see any serious deficiency in the information they get about the Institute and its activities. Only one in every six (16 per cent) mentions something about which he would like to be kept better informed. Of this 16 per cent, about one fourth mentions "Technical Committee activities."

AIEE MEETINGS

Exploring the subject of meetings now, the average AIEE member attends two section meetings a year. Factors which, according to members, limit their attendance are principally:

1. Competition of other activities—don't have the time to go.
2. Lack of interest in the subjects discussed.
3. Meetings are too far away.

Members favor greater emphasis on the professional aspects of section meetings, as compared with the social aspects. They would also like to see more talks and papers by section members, and more time allowed for discussion.

About half the members have attended one or more general meetings in the last 10 years. Considerations of time, cost, and distance are cited most often as reasons for not attending.

Special Technical Conferences are popular with the membership; three fifths of them would like to see an increased number of these conferences held.

Members were asked for their views on a number of possible changes in present section meetings and the results are brought out graphically in Chart 3.

This chart shows at a glance the views of the membership on a number of issues that have been debated by the officers and committee chairmen over quite a long period of time.

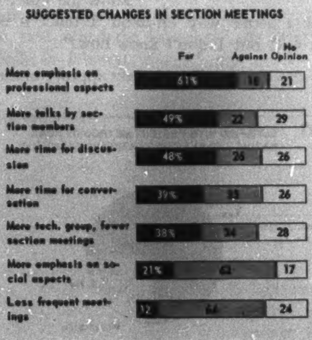

Chart 3

As is noted in Chart 3, there is a preponderance of opinion in favor of—

More emphasis on the professional aspects of the meetings.

More talks and papers by section members.

Allowing more time for discussion of talks and papers.

Opinion divides about evenly on these two points—

Allowing more time for conversation and personal contacts.

Holding more technical group meetings and fewer sections meetings.

Majorities of members are opposed to—

Putting more emphasis on social aspects of the meetings.

Holding section meetings less frequently.

A good perspective of attendance at "general" and "district" meetings is presented in Chart 4.

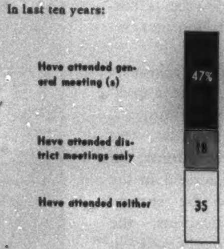

Chart 4

Nearly half of the membership (47 per cent) has attended a general meeting during the last 10 years; it is not the same group, as has been contended, that always attends these meetings. With the total membership at nearly 50,000, and the average attendance at a general meeting well under 5,000, many different individuals have attended the general meetings.

Among the 47 per cent who have been to one or more general meetings, the average (median) number of meetings attended in the 10-year period is three.

Of the 53 per cent who have not been to any general meetings in the last 10 years, one third (18 per cent) say they have attended district meetings.

As already indicated, members express considerable interest in having more Special Technical Conferences—national meetings on a specific technical subject, often sponsored jointly with other technical societies. A total of 60 per cent would like to see more of these conferences held. "Power" and "electronics" get top mention as the fields in which members would like to have more Special Technical Conferences.

AIEE PUBLICATIONS

Publications play a key role in the advancement of knowledge which, according to members' own testimony, is a prime reason for belonging to the Institute. Because they are not specialists in the field, members cannot be expected to furnish the blueprints for a complete publications program. However, they suggest changes which might be made so that the publications will even better serve members' interests and needs.

Probably the most serious problem of the present publications is the need for more strength in the communication and electronics field. Members tend to feel that the Institute should be devoting more attention to this field in its publications.

Only about half of those who receive the present bimonthly publications, and know that they are free, say they would subscribe if the cost were $2.50 a year.

As indicated in Chart 5, an overwhelming majority of 97 per cent approve the principle of Technical Committee review of Transactions papers before they are accepted for the bimonthly publications.

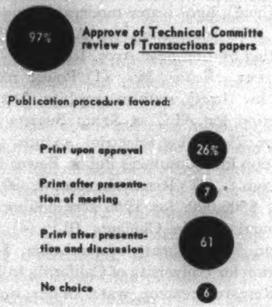

Chart 5

Three possible procedures for printing Transactions papers in the bimonthly publications were explored with the members interviewed in this survey, as follows:

1. Print the paper as soon as it is approved by the appropriate Technical Committee.
2. Print the paper as soon as it is approved by the appropriate Technical Committee and presented at a meeting.
3. Print the paper after it is approved by a Technical Committee and presented at a meeting and two weeks allowed for submission of discussion on the paper (present procedure).

As shown in Chart 5, a 61-per-cent majority of the members as a whole favor the present procedure of publishing papers only after presentation at meetings and after allowing time for discussion.

Among members who receive *Communications and Electronics*, however, 43 per cent favor the first procedure, as compared with 42 per cent who favor the third, which is the present procedure.

Conceivably, the opinions documented in Chart 5 may overstate the amount of active support for the present system. This question invokes the "power of the status quo," and some members who have not thought much about the problem may simply vote for the present method.

With specific reference to *Electrical Engineering*, one of the questions asked was:

> "What suggestions for improvements do you have in the format or content of *Electrical Engineering?*"

As noted in Chart 6, 49 per cent of the respondents had no suggestions.

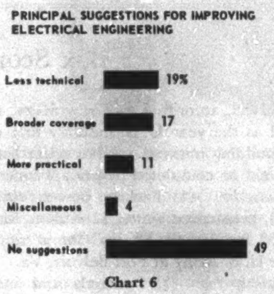

Chart 6

The two ideas expressed most often are that it should be less technical—19 per cent say this—and that it should give broader coverage—17 per cent say this.

Another very challenging and provocative question asked about the Institute publications was this one: "Suppose there were no AIEE publications and you were asked to develop a set of publications for the organization. If you were starting from scratch this way, what kinds of publications would you specify for the AIEE?" The largest proportion (37 per cent) express satisfaction with the present set of publications, and indicate that they would follow the same pattern. However, the next largest number (20 per cent) suggest individual publications for the various fields. A total of 14 per cent vote for technical publications and more general interest articles.

This question brought forth many individual suggestions and recommendations; these verbatim comments comprise eight single-spaced typewritten $8^1/_2$- by 11-inch pages in the complete report of the survey.

SUPPLEMENTAL DATA

At the conclusion of the interview, the members were asked several questions about their age, when they first joined the AIEE, about their employment status, and their membership in other societies, thus providing information which Headquarters did not have about the composition of the membership. Some very interesting and useful facts were obtained, one of which is that the AIEE is composed of many relatively young men; almost two-thirds of the membership (64 per cent) are under 45 years of age, and 17 per cent are under 30. Almost one half of the present members (48 per cent) first joined the Institute less than 10 years ago. A total of 13 per cent of the membership have been at one time or another an officer or a member of a national committee. Approximately 95 per cent work for someone else, and about 5 per cent are self-employed. About one half (47 per cent) are also members of other professional societies or associations.

The sample for this survey was drawn by a process of systematic selection from the AIEE Yearbook, so that it would be representative of the United States membership as a whole with respect to such criteria as membership grade and regional distribution. The actual sample of members interviewed was very closely representative—within 1 per cent—of the membership as a whole in terms of these characteristics.

All of the vice-presidents of the Institute have been furnished with a set of 21 colored 2- by 2-inch slides highlighting the findings in the survey, and will be prepared to discuss these findings at various meetings of the membership throughout the country.

Institute leaders have commented most favorably on the value of the survey, pointing out that it provides a comprehensive and factual picture of member attitudes and opinions, which will serve to guide the officers and committee members in plans and policy-making decisions that will serve the best interests of the AIEE.

Box Score of the Reactor Business

The year 1955, according to *Forum Memo*, may well be remembered as the year U. S. industry first entered into the reactor building business. A box score listing all contracts now held or completed by private concerns follows:

Alco Products, Inc. (1) Package power prototype, 2,000 kw (electric), pressurized water, $2 million, for completion in early 1957 for Atomic Energy Commission (AEC) on behalf of the U. S. Army at Fort Belvoir, Va.

AMF Atomics, Inc. (1) Research and industrial test reactor, 1,000 kw (heat), swimming pool, $1.5 million, for completion in early 1956 for Battelle Memorial Institute at Columbus, Ohio; (2) Research and industrial test reactor, 1,000 kw (heat), swimming pool, $1.5–$2 million, for completion in late 1956 for AMF Atomics and eight associated firms, in the New York City area; and (3) Research reactor, swimming pool, $750,000, University of Buffalo.

Babcock and Wilcox Company. (1) Research reactor, 1,000 kw (heat), swimming pool, for completion in 1956 for University of Michigan at Ann Arbor, Mich.; and (2) Power reactor, 140,000 kw (electric), pressurized water, $55 million, for completion in 1959 for Consolidated Edison Company of New York at Peekskill, N. Y.

Combustion Engineering, Inc. (1) Submarine propulsion reactor prototype, for AEC on behalf of the U. S. Navy.

Foster Wheeler Corporation. (1) Research reactor, swimming pool, $350,000, for completion late in 1956 for AEC's Livermore Laboratory in Livermore, Calif.

General Dynamics Corporation (*Convair Division*). (1) Medical research reactor, 1,000 kw (heat), $2.5 million, for 1956 completion for Lovelace Foundation, Albuquerque, N. M.

General Electric Company. (1) Power reactor, 180,000 kw (electric), boiling water, $45 million, for 1960 completion for Commonwealth Edison Company and Nuclear Power Group, Inc., in Grundy County near Chicago, Ill.; (2) Submarine propulsion reactor prototype, 10,000 kw (electric), sodium cooled, operated in 1955 for AEC on behalf of U. S. Navy at West Milton, N. Y.; (3) Submarine propulsion reactor, sodium cooled, for 1956 completion for AEC on behalf of the U. S. Navy, to propel the submarine *Seawolf;* and (4) Submarine propulsion reactor prototype, pressurized water, $23 million, to be built for AEC on behalf of the U. S. Navy at West Milton, N. Y.

Kaiser Engineers. (1) High-flux engineering test reactor, 175,000 kw (heat), light water moderated and cooled, $15 million, for 1957 completion for AEC at the National Reactor Testing Station near Arco, Idaho.

North American Aviation, Inc. (1) Power reactor prototype, 20,000 kw (heat), sodium graphite, $10 million, for 1956 completion for AEC at Santa Susana, Calif.; (2) Power reactor, 75,000 kw (electric), sodium graphite, for 1959 completion for Consumers Public Power District near Columbus, Neb.; (3) Research reactor, 50 kw (heat), water boiler, $500,000, for 1956 completion for Armour Research Foundation in Chicago, Ill.; (4) Medical research reactor, 50 kw (heat), water boiler, $500,000, for 1956 completion for University of California in Los Angeles, Calif.; (5) Research reactor, water boiler, operated since 1953 for AEC's Livermore Laboratory in Livermore, Calif.; (6) Research reactor, water boiler, Santa Susana, Calif.

Westinghouse Electric Corporation. (1) Power reactor, 60,000 kw (electric), pressurized water, $37.5 million, (nuclear portion only), for 1957 completion for AEC and Duquesne Light Company at Shippingport, Pa.; (2) Power reactor, 150,000 kw (electric), homogeneous, for 1962 completion for Pennsylvania Power and Light Company in eastern Pennsylvania; (3) Power reactor, 11,500 kw (electric), pressurized water, $5 million (estimated), for 1958 completion for the Syndicat d'Etude de l'Energie Nucleaire in Brussels, Belgium; (4) Industrial test reactor, 10,000 kw (heat), light water moderated and cooled, $6.5 million, for 1957 completion for Westinghouse's own use at Blairsville, Pa.; (5) Submarine propulsion reactor prototype, pressurized water, operated since 1953 for AEC on behalf of the U. S. Navy at Arco, Idaho; (6) Submarine propulsion reactor, pressurized water, operated since 1955 in the submarine *Nautilus;* (7) and (8) Two submarine propulsion reactors, pressurized water, $12.4 million, U. S. Navy; (9) Large surface ship propulsion reactor prototype (twin reactors powering a single shaft), pressurized water, $25 million, for AEC on behalf of the U. S. Navy, Arco, Idaho.

New Direct-Acting Recording Instruments

L. J. LUNAS
MEMBER AIEE

J. C. NYCZ
ASSOCIATE MEMBER AIEE

EARLY RECORDING INSTRUMENTS were projection mounted, with either the complete case and cover removable for maintenance or the housing made large enough for convenient access through a door.

Modern switchboard design practice is to mount instruments with their front covers flush with the panel surface. Furthermore, centralization of electric and mechanical instrumentation makes it necessary to mount large numbers of recording instruments within a small area. Thus, a need has arisen for a compact-design recording instrument, requiring minimum panel space and providing convenient and easy accessibility for servicing and maintenance. To meet this need, a completely new line of recording instruments has been designed to occupy no more panel area than older design instruments, but with all maintenance operations and adjustments conveniently accessible from the front. These include not only routine operations of renewing the chart and filling the inkwell, but also other service operations such as adjusting the damping, adjusting the movement stops, and making the calibration adjustments, as well as changing the scale plate.

The side-hinged cover and case assembly has been designed for improved visibility of the chart and scale, and for simple opening and closing of the cover with dust-tight seal.

Three new and different types of measuring mechanisms have been developed for various types of a-c and d-c measurements. These have marked increase in efficiency over existing mechanisms, as well as superior overload capacity and low power consumption.

The chart-driving mechanism is a unit assembly arranged to tilt forward to provide convenient access for maintenance operations, and is easily lifted out of the recorder frame, when necessary. Chart change-speed gears provide speeds of 3/4, $1^{1}/_{2}$, 3, 6, and 12 inches per hour. A 2-speed chart-timing mechanism adds the corresponding speeds in inches per minute.

The inking system is unique in that the pen is not disturbed when the inkwell is lowered for filling. The inkwell remains in the inkwell bracket and need not be removed from the instrument while being filled. The pen is mounted to permit easy removal for adjustment.

Optimum operating torque of the mechanisms has been determined from a fundamental investigation to be in the order of 150 cm-gm, measured on the basis of a spring deflection of 360 degrees. The factors included in the study were pen-to-paper friction, response time, writing ability at high speeds, and limitations imposed by the double-frequency response of the moving system at higher torques. Previous limitations of power consumption, overload capacity, and damping have been eliminated by the development of modern high-efficiency mechanisms and damping systems.

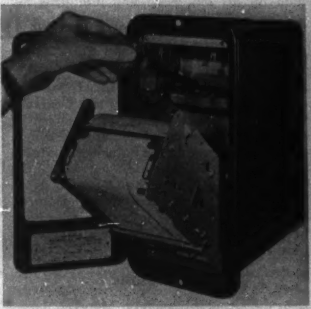

Fig. 1. Direct-acting recording instrument, during inkwell - refilling operation

The permanent-magnet moving-coil mechanism for d-c voltages and currents and for rectifier and transducer measurements utilizes Alnico *V* magnets and a 1-piece laminated magnetic structure. A unique system of magnetic shunt calibrators provides an adjustment range of 40 per cent with no perceptible influence on scale distribution. Standard power consumption is 0.0025 watt full scale but power consumption can be reduced to 0.001 watt full scale by reducing torque to 100 cm-gm for 360 degrees and omitting the shunt calibrators.

An attraction-iron type of mechanism was chosen for a-c voltmeters and ammeters because of its simplicity, high magnetic efficiency, and high mechanical and electric overload capacity.

The inherent square-law torque characteristic of this type of mechanism gives rise to severe mechanical stressing of the moving-element system during suddenly applied overloads. This has been eliminated by coupling the rotor to the rest of the moving element through a biased auxiliary spring. Sudden overloads forcefully deflect the rotor but the rest of the moving element moves up-scale more gradually by the action of the auxiliary biasing spring.

The mechanism used for wattmeters and varmeters utilizes a 1-piece lamination with close magnetic coupling between the moving and stationary coils. This results in high magnetic and electrical efficiency, as well as consistently uniform scale distribution.

Proper arrangement and proportioning of the magnetic circuit eliminates solenoid effect and voltage errors.

In each element both the moving and stationary coils are divided into pairs and astatically connected, making the element immune to the effect of uniform stray fields.

Digest of paper 55-484, "A New Line of Direct-Acting Recording Instruments," recommended by the AIEE Committee on Instruments and Measurements and approved by the AIEE Committee on Technical Operation for presentation at the AIEE Summer General Meeting, Swampscott, Mass., June 27–July 1, 1955. Scheduled for publication in AIEE *Communication and Electronics*, 1955.

L. J. Lunas and J. C. Nycz are with Westinghouse Electric Corporation, Newark, N. J.

The authors wish to express appreciation to D. A. Young, Westinghouse Electric Corporation, who conceived and promoted many of the principles and unique features incorporated in the design of these recording instruments.

INSTITUTE ACTIVITIES

1956 Winter General Meeting Will Be Largest in AIEE's History

THE AIEE WINTER GENERAL Meeting to be held at the Hotels Statler and Governor Clinton in New York, N. Y., January 30 to February 3, 1956, will feature the largest technical program in the history of the Institute. The social activities, for which the Winter General Meeting also is known, again will be one of the outstanding features. Varied and interesting inspection trips have been arranged, closely allied with the technical sessions.

General Session

At the General Session on Monday, January 30 at 2:00 p.m., Roger Blough, chairman of the board of directors of the United States Steel Corporation, will give the principal address. Just prior to Mr. Blough's remarks, past President James F. Fairman will be given an Honorary Member award in our Institute. Also, at this time the Alfred Noble Paper Prize will be awarded to R. L. Bright of the Carnegie Institute of Technology. At this same meeting, the Institute paper prizes will be awarded. President M. D. Hooven will open the session with his report to the membership.

At a special session Tuesday 1:45 p.m., the Edison Medal will be presented to L. A. Umansky of the General Electric Company. The public is cordially invited to these two sessions.

Technical Sessions

Over 500 papers will be presented in some 100 technical sessions ranging through the five broad fields of Institute activities—communications, general applications, industry, power, and science and electronics. In addition, sessions will be sponsored by general committees of the Institute in the fields of ethics, management, safety, education, and research. Among the 40-odd sessions of the power division, 1 session on the 330-kv system to be held Tuesday morning, will be devoted to the transmission, transformation, switching, and relaying of this high voltage. At this meeting three new committees are sponsoring sessions on the subjects of information, theory, dielectrics, and solid-state devices.

Under the sponsorship of the Committee on Research three important sessions will be held, one of which will be on the subject of research and education. The first of these sessions will be composed of reports on research by and for the electric power industry in Sweden, Italy, Japan, Germany, and Great Britain. The third session will be composed of papers on the subject of research in the field of fuels. Of note are two joint sessions. The first will be sponsored by the Committees on Wire Communications and Transmission and Distribution, and the second will be organized by the Committees on Television and Aural Broadcasting and Production and Application of Light. The Marine Transportation Committee has again selected the Winter General Meeting to sponsor a session in this important field. The Committee on Industrial Power Rectifiers formerly the Electronic Power Converters, will sponsor two sessions on Wednesday.

Hotel Reservations

Blocks of rooms have been set aside at the Governor Clinton, Statler, and nearby hotels for members and guests attending the meeting. Requests for reservations should be sent to the hotel of your choice, specifically referring to the AIEE meeting in your letter. Please do not write to more than one hotel. If your request cannot be filled, the hotel will automatically refer your request to the Hotel Accommodations Committee whose duty it is to obtain a similar reservation at another of the convention hotels for you. The hotel will confirm directly to you. No guarantee that you will be housed satisfactorily can be made if your request is received after January 16, 1956.

Because of the crowded conditions in New York hotels, it is suggested that your reservation be made for arrival on Sunday, January 29, 1956, thereby avoiding delays in registration or unavailability of rooms in the early morning of subsequent days. It is also suggested that a request for reservation prior to Christmas is more likely to be filled at the hotel of your choice.

Rooms have been allotted for our use by the following hotels at the daily rates indicated below:

Hotel Statler (meeting headquarters), 7th Avenue, 32nd to 33rd Streets

Single room	$ 7.00 to $11.00
Double room	10.00 to 14.00
Twin bedroom	10.50 to 18.00
Suites	29.00 to 30.00

Hotel Governor Clinton (also used for meetings), 7th Avenue at 31st Street

Single room	$ 6.00 to $11.00
Double room	8.50 to 14.00
Twin bedroom	10.00 to 16.00

Hotel McAlpin, Broadway and 34th Street

Single room	$ 5.50 to $10.50
Double room	8.00 to 15.00
Twin bedroom	9.50 to 15.50

Hotel Commodore, Lexington Avenue and 42nd Street

Single room	$ 6.00 to $11.50
Double room	9.50 to 14.00
Twin bedroom	11.00 to 17.00

Hotel Martinique, Broadway and 32nd Street

Single	$ 5.00 to $11.00
Double room	8.00 to 14.00
Twin bedroom	8.00 to 14.00

All rooms have private bath and the rates quoted are subject to a 5 per cent New York City hotel room tax.

There will be no rooms available at the New Yorker or Roosevelt this year due to conflicts with other meetings, but allotments have been increased at other hotels accordingly.

Smoker Committee

A highlight of the Winter Meeting will be the Smoker to be held on Tuesday evening January 31, 1956. Good food, good fellowship, and top quality entertainment will feature this event which will be held in the Hotel Statler.

Attendance will be limited to improve the

PROCESSING CENTER at IBM's New York Electronic Data Headquarters, which is included in the list of scheduled inspection trips for the Winter General Meeting.

AERIAL VIEW of the new Mahwah, N. J., automobile assembly plant of the Ford Division of the Ford Motor Company. AIEE members attending the 1956 Winter General Meeting will be able to visit the plant as it is one of the many inspection trips that have been arranged.

comfort of guests and ticket requests should therefore be made at an early date. They should be addressed to D. Halloran, Room 1250 S, 4 Irving Place, New York 3, N. Y., and should be accompanied by checks made payable to "AIEE Smoker Committee." The ticket price will be $10 per person.

Theater Tickets

As in the past, tickets to the following shows currently playing in New York will be available to AIEE members during the week of the meeting. All prices shown are brokers' prices.

	Evenings		Matinees
	M,T,W,T	F,S	W
A View from the Bridge Arthur Miller with Van Heflin, J. Carrol Naish	$6.85	$6.85	$5.15
Bus Stop William Inge with Barbara Baxley	5.70	6.85	*5.15
Fanny Walter Slezak, Ezio Pinza	8.60	8.60	5.40
Inherit the Wind Paul Muni	5.70	6.85	5.15
The Pajama Game Helen Gallagher, John Raitt	8.00	8.00	5.15
Plain and Fancy Richard Derr	8.00	8.00	5.25
Silk Stockings Cole Porter with Don Ameche, Hildegarde Neff	8.60	8.60	5.90
The Teahouse of the August Moon John Beal	5.70	7.35	5.15
Tiger at the Gates Michael Redgrave	6.85	6.85	5.15
Witness for the Prosecution Agatha Christie with Francis L. Sullivan, Patricia Jessel	5.70	6.85	*5.15

*Mats. Thurs.

Checks should be made payable to: "Theater Ticket Committee, AIEE." Requests also should include first and second choice of both name and date of show, and should be sent to: Theater Ticket Committee, AIEE, c/o S. Friend, Jr., 75 Buena Vista Drive, Dobbs Ferry, N. Y.

Dinner-Dance

The Dinner-Dance, climax of the social affairs planned for the Winter General Meeting, is scheduled for Thursday, February 2, 1956, at 7:00 p.m. in the Grand Ballroom of the Hotel Statler. Music will be by Charles Peterson and the food will be better than ever. Dress will be formal. Plan now and write soon for tables for 10 or individual places. Address requests to: E. J. Doyle, American Telephone and Telegraph Company, 195 Broadway, New York 7, N. Y. Tickets are $12 each and checks should be made payable to "AIEE Dinner-Dance Committee."

Inspection Trips

A program of inspection trips of both technical and general interest has been arranged for those attending the Winter General Meeting. Since the number of people who can be accommodated on these trips is limited, members who plan to take any of these trips are urged to make arrangements at the Inspection Trips' Desk immediately after registering.

Informal Tea

This social gathering before the formal program begins has been enjoyed by more and more people each year. Make it a point to attend this year—Sunday afternoon, January 29, from 4 to 6 p.m., in the Georgian Room of the Statler. There will be no charge.

During this period the registration facilities will be open for those wishing to avoid the Monday morning rush.

Fairless Steel Plant, Fairless, Pa. (*Tuesday, All Day, January 31*). The Fairless Works is U. S. Steel's first integrated steel plant in the East, and covers 3,900 acres of land near Trenton, N. J., of which 175 are under roof. The inspection party will see all of the operations from the stock pile of raw materials (iron ore, coal, and limestone) through the blast furnaces, and open hearth plant to the hot strip mill and sheet and tin finishing mills. This plant has an annual capacity of approximately 1,200,000 tons of pig iron which, when used in the plant's nine open hearth furnaces, furnish 1,800,000 tons of steel. The large amount of electric equipment used for driving and controlling various operations in the mills will also be of interest to members.

Radio City Music Hall, New York, N. Y. (*Tuesday morning, January 31*). This ever popular trip has been scheduled again. Spectacular stage shows distinguished by unique lighting effects have made the Radio City Music Hall an outstanding attraction for visitors from all over the world. Members will see the backstage facilities as well as unusual features, such as the revolving sectionalized stage, elevating orchestra pit, motorized curtains, and the multitude of electric and mechanical controls required for the special stage and lighting effects.

International Business Machines Corporation, New York, N. Y. (*Tuesday morning, January 31, Wednesday afternoon, February 1, Thursday afternoon, February 2*). IBM will demonstrate and explain the operation of their Type-705 Electronic Data Processing Machine, Type-704 Electronic Data Processing Machine, and Type-650 Magnetic Drum Data Processing Machine and High Speed Printer. In addition, numerous other electronic devices will be exhibited and the operation of many will be explained by technical personnel.

Charles Pfizer and Company, Brooklyn, N. Y. (*Tuesday afternoon, January 31*). An inspection and illustrated lecture at the main plant of the world's largest producer of antibiotic drugs. Modern laboratories engaged in the research that leads to the invention and discovery of new drugs including vitamins and hormones as well as antibiotics can be seen. In the search for new antibiotics, Pfizer has screened more than one million soil samples in the last 8 years. In addition to the laboratories, the visitor will see how the pharmaceutical industry has developed and invented new machinery for the processing and packaging of drugs. The visitor will also see how capsules, tablets, and other medicines are produced through the use of the most modern equipment.

Kearny Generating Station, Kearny, N. J. (*Tuesday afternoon, January 31*). This new generating station of the Public Service Electric and Gas Company contains two 145,000-kilowatt steam turbine-generator units. These tandem-compound, 3,600-rpm turbine-generators are unique in respect to their elevated steam conditions: 2,350 psig, 1,100 F at throttle and 1,050 F reheat temperature. The boilers, each as tall as an 11-story building, produce a million pounds of steam an hour and feature controlled circulation, pressurized firing, twin furnaces, and flue-gas recirculation. Each of the twin furnaces is equipped for tilting tangential

Future AIEE Meetings

AIEE, IRE, ACM National Simulation Conference
Baker Hotel, Dallas, Tex.
January 19, 20, 21
(*Final date for submitting papers—closed*)

Winter General Meeting
Hotel Statler, New York, N. Y.
January 30–February 3, 1956
(*Final date for submitting papers—closed*)

AIEE-IRE-ACM Western Computer Conference
Fairmont Hotel, San Francisco, Calif.
February 8–10, 1956
(*Final date for submitting papers—closed*)

AIEE-IRE University of Pennsylvania Transistor Circuit Conference
University of Pennsylvania
Philadelphia, Pa.
February 16–17, 1956
(*Final date for submitting papers—closed*)

Scintillation Counter Conference
Shoreham Hotel, Washington, D. C.
February 28–29, 1956
(*Final date for submitting papers—closed*)

Southern Textile Conference
Georgia Institute of Technology, Atlanta, Ga.
March 1–2, 1956
(*Final date for submitting papers—closed*)

Paper and Pulp Conference
University of Florida, Gainesville, Fla.
March 8–9, 1956
(*Final date for submitting papers—closed*)

AIEE, Illinois Institute of Technology American Power Conference
Sherman Hotel, Chicago, Ill.
March 21–23, 1956
(*Final date for submitting papers—closed*)

AIEE-ASME Nonlinear Controls Conference
Princeton University, Princeton, N. J.
March 27–29, 1956
(*Final date for submitting papers—closed*)

South West District Meeting
Baker Hotel, Dallas, Tex.
April 2–4, 1956
(*Final date for TP—Jan. 3, ‡DP Syn.—Jan. 18 DPMs—Feb. 2*)

AIEE-IRE-ISA Magnetic Amplifiers Conference
Syracuse Hotel, Syracuse, N. Y.
April 5–6, 1956
(*Final date for submitting papers—January 5*)

Rubber and Plastics Conference
Mayflower Hotel, Akron, Ohio
April 9–10, 1956
(*Final date for submitting papers—January 9*)

Great Lakes District Meeting
Fort Wayne, Ind.
April 16–18, 1956
(*Final date for TP—Jan. 16, ‡DP Syn.—Feb. 1 DPMs—Feb. 16*)

AIEE, ASME, ISA Recording and Controlling Instruments Conference
Bradford Hotel, Boston, Mass.
April 26–27, 1956
(*Final date for submitting papers—Jan. 26*)

AIEE-IRE Electronic Material and Component Symposium
Washington, D. C.
May 1–3, 1956
(*Final date for submitting papers—February 1*)

North Eastern District Meeting
Rochester, N. Y.
May 2–4, 1956
(*Final date for TP—Feb.* 1, *‡DP Syn.—Feb. 15 DPMs—March 2*)

*TP—Transactions paper
†CP SYN.—Conference Synopsis
CP MS—Conference Manuscript
(The CP Syn. date is 15 days before the CP Ms date)
‡DP SYN.—District Synopsis
DP MS—District Manuscript (the DP Syn. date is 15 days before the DP Ms date)

corner firing of either coal or oil. The modern soundproofed and air conditioned control room is equipped with over 500 instruments and controls including television apparatus for the control and supervision of these two turbine-generator units.

Brookhaven National Laboratory, Upton, N. Y. (*Wednesday, All Day, February 1*). The facilities at this location are operated by Associated Universities, Inc., under contract with the Atomic Energy Commission, and constitute the Northeastern Center for nuclear research and development in the fields of physics, chemistry, biology, medicine, and engineering. Among the important exhibits that members will see are the atomic pile, the cosmotron, and the hot laboratory. A complete tour has been arranged in great detail and competent guides, engineers, and scientists will be on hand to explain fully the extensive facilities and exhibits which have been erected at this vast site. Members must sign up for this trip before 12 noon, January 31, 1956. (U. S. citizens only.)

Western Electric Company, Kearny, N. J. (*Wednesday, All Day, February 1*). One of the largest manufacturing plants for the Bell Telephone system. Included in this tour will be the multiconductor cable shop, relay blade manufacturing, and assembly of manual and automatic switchboard equipment.

American District Telegraph Company, New York, N. Y. (*Wednesday morning, February 1, Thursday morning, February 2*). This trip covers working demonstrations and explanatory commentary on ADT's electric protection systems against burglary, holdup, intrusion, fire, and special hazards. The systems include a number of electronic systems using modulated photoelectric, body capacitance, sound detection, and ultrasonic equipment.

Ford Motor Company, Mahwah, N. J. (*Wednesday morning, February 1*). This plant, located on a 177-acre tract, is the largest automobile and truck assembly plant in the world. A 1-story building 2,115 feet long and 792 feet wide (provides 40 acres under 1 roof), it is capable of turning out 1,080 cars and trucks in a 2-shift 16-hour day. Extensive receiving and shipping facilities permit the unloading of 96 railroad cars within the plant at one time. Over 11 miles of conveyor belts and a lighting system designed to give 30 foot-candles of light on a 30-inch plane throughout the plant (requires 31,500, 8-foot light tubes) makes this new plant, which was dedicated in September 1955, the pride of the Ford Company.

New York, New Haven and Hartford Railroad Shops, New York, N. Y. (*Wednesday morning, February 1*). Van Nest Shops is a brick structure, 800-feet long by 260-feet wide. It is divided into two sections, one for inspection of locomotives and cars and the other for major repairs and overhaul. There are approximately 400 employees engaged in the maintenance of 74 electric locomotives and 200 multiple unit cars. All work on this equipment, with the exception of daily inspection and miscellaneous minor repairs, is done at Van Nest Shops. Van Nest has an excellent motor repair shop with well-qualified armature winders to repair and rewind motors of any size, and all of this type of equipment on the system is taken care of at this point.

Otis Elevator Company, New York, N. Y. (*Wednesday afternoon, February 1*). A model Autotronic Elevator System installed in a miniature 10-story building will be demonstrated, and the operation of the controlling electronic brain will be explained. This model has been exhibited in various parts of the United States and Canada. The demonstration will be followed by a question and answer period.

U. S. Merchant Marine Academy, Kings Point, N. Y. (*Thursday, All Day, February 2*). This trip will consist of a general inspection of the facilities at the Academy. The outstanding features are the engineering laboratories and the laboratories relating to nautical science such as navigation, seamanship, naval architecture, etc. All the laboratories contain equipment found on board ship and all equipment is in operating condition. The electrical laboratory contains an actual turbine-electric propulsion system, while the electronics laboratory has radar, loran, radio detection finder, fathometer, gyro compasses, degaussing systems, radio transmitters, and telephonic equipment.

Triangle Conduit and Cable Company, New Brunswick, N. J. (*Thursday morning, February 2*). Founded in Brooklyn in 1916 as a flexible steel conduit and armored cable plant, Triangle Conduit and Cable Company has grown to be one of the leaders in the manufacture of quality insulated wire and cable and conduit, both rigid and electrical metallic tubing. The present wire and cable facilities alone consist of a 335,000-square-foot plant in New Brunswick, now the headquarters of the company. In this plant the visitor will see copper enter the factory in the form of bars and emerge as high-quality insulated wire and cable. In between, there are many interesting processes involved to observe—the

(*Continued on page 76*)

Tentative Technical Program
AIEE Winter General Meeting, New York, N. Y., January 30–February 3, 1956

Monday, January 30

10:00 a.m. Carrier Current

56-64. Attenuation Measurements, Bureau of Reclamation, Alva B. Adams Tunnel, 69-Kv Cable. *R. W. Beckwith, D. C. Pinkerton*, General Electric Company; *C. H. Murray*, Bureau of Reclamation

56-65. The Application of Power Line Carrier to a Combined Cable and Overhead Circuit. *J. D. Moynihan*, Sprague Electric Company; *E. G. Allyn*, Detroit Edison Company

56-11. Bibliography of Power System Communication Literature. *Subcommittee on Bibliography*

CP.* Symposium—Application of Microwave Equipment to Power Systems. *T. A. Cramer*, General Electric Company

10:00 a.m. System Engineering

56-158. A New Approach to Forecasting Daily Peak Loads. *D. K. A. Gillies, B. Bernholtz, P. J. Sandiford*, The Hydro-Electric Power Commission of Ontario

56-58. What Do Losses Cost in Hydro, Thermal, and Combined Systems? *V. W. Ruskin*, British Columbia Electric Company, Ltd.

CP56-159. An Equitable Method for the Distribution of Power Pool Savings. *H. W. Phillips*, Philadelphia Electric Company

CP56-160. The Calculation of Block Tariffs. *T. D. Oswald*, Electricity Department, Singapore, Commonwealth of British Malaya

CP56-161. Maintenance Costs as an Electrical Design Consideration. *C. J. Slatt, W. S. Acton, C. C. Dismond*, Bonneville Power Administration

10:00 a.m. General Circuit Theory

CP56-117. Analysis of Electric Circuits Containing Nonlinear Resistance. *L. A. Pipes*, University of California

CP56-118. The Existence of an Electric Analogue of a Magnetic Circuit Established by the Basic Laws Defining Magnetostatics. *E. C. Koenig*, Allis-Chalmers Manufacturing Company

CP56-119. Analysis and Design of the Ferroelectric Resonant Trigger Pair. *C. E. Gremer*, United States Navy, Naval Guided Missile School

CP56-120. Eddy Currents in a Frog-Leg Winding. *A. I. Dvoracek*, Research and Resettlement Branch, USAREUR

56-121. Representation of Nonlinear Characteristics by Linear Elements. *M. S. M. Abou-Hussein*, University of Cairo. Re-presented for discussion

56-122. Impedance Tensor of General Electric Machine. *Yao-nan Yu*, National Taiwan University. Re-presented for discussion

10:00 a.m. Instruments and Measurements

CP56-97. Electric Potential Changes at Surfaces as a Means of Measuring Odorous Atmospheric Contamination. *C. R. Chapman, J. R. Eaton*, Purdue University

56-98. Two New Total Radiation Pyrometers. *W. Dergane, S. N. Howell*, Servo Corporation of America

CP.* Automatic Digital Recording of Flight Test Data. *S. Cohen, L. Goldfischer*, General Precision Laboratories, Inc.

CP56-99. Segmental Multirecording Instruments. *George Keinath*, Larchmont, N. Y.

10:00 a.m. Solid State Devices

CP.* High-Frequency Junction Transistors. *J. M. Early*, Bell Telephone Laboratories, Inc.

CP.* Discussion of a New Type Power Transistor. *Joseph Maupin*, Minneapolis-Honeywell Regulator Company

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CP.* Recent Developments in Silicon Power Rectifiers. *R. L. Bright*, Westinghouse Electric Corporation

CP.* Partial Transistorization of a Communication Receiver. *G. A. Allard*, General Electric Company

CP.* Analysis of Temperature Stabilization in Transistor Amplifiers. *L. M. Vallese*, Polytechnic Institute of Brooklyn

CP56-94. Transistor Power Amplifiers with Switched Mode of Operation. *A. G. Milnes*, Carnegie Institute of Technology

CP.* Field Effect Transistor Application. *Chaang Huang, Melvin Marshall, B. H. White*, Sylvania Electric Corporation

CP.* Power Transistor Switching Circuits. *Edwin Slobodzinski, Chaang Huang*, Sylvania Electric Corporation

10:00 a.m. Land Transportation

CP56-95. Modernization of the Long Island Railroad Passenger Car Fleet. *P. H. Hatch*, Long Island Railroad Company

CP.* Light Weight Train and its Electric System *J. L. Swarner*

CP56-96. Outline of Improvements Made in the Design, Maintenance, and Operation of the C. M. St. P. & P. RR. Electrification. *Laurence Wylie*, Chicago, Milwaukee, St. Paul, and Pacific Railroad

55-627. Harmonics from Railroad Rectifiers on Power System Reduced by Filters. *S. J. Bozzella*, Long Island Lighting Company; *J. L. Kennedy*, Long Island Railroad Company; *M. Mahr, Jr.*, New York Telephone Company; and *H. W. Wahlquist*, Ebasco Services, Inc.

10:00 a.m. Communication Switching Systems

56-162. Several-Valued Combinational Switching Circuits. *C. Y. Lee*, Bell Telephone Laboratories, Inc.; *W. H. Chen*, University of Florida

CP.* A Serial Method for Numbering the Slots on a Magnetic Drum. *J. J. Yostpille, A. E. Joel*, Bell Telephone Laboratories, Inc.

CP.* New Telephone Network Switching Facilities. *A. E. Batchelet, C. A. Collins, E. R. Taylor*, Bell Telephone Laboratories, Inc.

CP.* Principles of Operation of the North By-Path Crossbar System. *Eric Brooks*, North Electric Company

10:00 a.m. Corrosion of Line Hardware

56-230. Corrosion as it Affects Insulator and Conductor Hardware. *A. W. Bardeen, J. M. Sheadel*, The Ohio Brass Company

CP.* Field Experiences with Corrosion. *A. S. Hatfield*

CP.* Corrosion of Line Hardware. *L. P. Schmitt*, The Joslyn Company

CP.* Corrosion of Line Hardware. *R. H. Amundson*, Line Material Company

10:00 a.m. Power Systems for the Steel Industry

CP.* Distribution Systems Practice in Steel Plants. *B. J. Auburn*, Auburn and Associates, Inc.

CP.* Power Generation in the Steel Industry. *W. P. Gavit, R. R. Wagstaff*, United Engineers and Constructors, Inc.

56-66. The Application of Reactance in the Design of Steel Mill Distribution Systems. *G. B. Scheer*, Kaiser Engineers

56-22. Economic Studies Applied to Industrial Power Systems. *H. B. Backenstoss*, Jackson and Moreland

10:00 a.m. Ethics in Engineering Practice

CP.* The Unfinished Business of Engineering Ethics. *P. L. Alger*. Panel Discussion of Case Problems. Opportunity for audience to express views on problems of ethics in discussion from the floor and through the "opinion meter." Members of Panel: *C. T. Chave, M. S. Coover, D. F. Langenwalter, C. F. Savage, and E. C. Starr*

10:00 a.m. Wire Communications and Transmission and Distribution

56-237. Co-ordinated Protection for Open Wire Joint Use—Present Trends. *W. R. Bullard*, Ebasco Services, Inc.; *H. E. Weppler*, American Telephone and Telegraph Company

56-238. Co-ordinated Protection for Open Wire Joint Use—Ontario Tests. *H. M. Ellis, R. E. Treen*, Hydro-Electric Power Commision of Ontario; *J. W. Phelps, C. L. Roach*, Bell Telephone Company

56-239. Co-ordinated Protection for Open Wire Joint Use—Minneapolis Tests. *A. E. Dietz*, Bell Telephone Laboratories, Inc.; *E. G. Albrecht*, Northwestern Bell Telephone Company; *E. W. Christoferson, J. C. Slothower*, Northern States Power Company

2:00 p.m. General Session

Address: *President M. D. Hooven*

Presentation of the Institute paper prizes

Presentation of the **Alfred Noble Prize** to *R. L. Bright*

Address: *Roger M. Blough*, Chairman of the Board of Directors, United States Steel Corporation

Tuesday, January 31

9:30 a.m. Section Delegates Conference

9:30 a.m. Substations

56-123. Short-Circuit Tests on 138-Kv Busses. *D. W. Taylor, C. M. Stuehler*, Public Service Electric and Gas Company

56-7. New Design of Control Installations in Transmission Stations. *G. M. Mulhern, D. W. O'Neill*, Electricity Supply Board, Ireland

CP56-42. Location and Design of Distribution Substations in Residential Areas. *J. W. Erven*, Los Angeles Department of Water and Power; *C. S. Fiske*, Baltimore Gas and Electric Company; *P. F. Hargreaves*, Puget Sound Power and Light Company; *E. M. Hunter*, General Electric Company; *P. R. Pierson*, Westinghouse Electric Corporation; *O. J. Rotty*, Union Electric Company of Missouri

9:30 a.m. Insulated Conductors

56-67. The Penetration of Electromagnetic Radiation into Ferro-Magnetic Material. *C. A. Adams*, Philadelphia, Pa.

CP* Conference papers will not be printed by the Institute; they may be available, however, at the meeting at the discretion of the author.

56-68. Oil Flow and Pressure Calculations for Self-Contained Oil-Filled Cable Systems. *F. H. Buller*, General Electric Company; *J. H. Neher*, Philadelphia Electric Company; *F. O. Wollaston*, British Columbia Electric Company

56-69. Charging Current Limitations in Operation of High-Voltage Cable Lines. *C. S. Schifreen, W. C. Marble*, Philadelphia Electric Company

9:30 a.m. 330-Kv System

57-231. Lightning and Corona Performance of 330-Kv Lines on the American Gas and Electric and Ohio Valley Electric Corporation Systems. *W. S. Price, S. C. Bartlett, E. S. Zoble*, American Gas and Electric Service Corporation

56-232. Line Dropping Tests on a 330-Kv Oil Circuit Breaker. *Otto Naef*, American Gas & Electric Service Corporation; *R. E. Friedrich*, Westinghouse Electric Corporation

56-233. 330-Kv Power Transformer with Compensation to Provide Accurate Low-Voltage Metering Potential. *P. S. Pugh*, American Gas and Electric Service Corporation; *T. G. Gerwing*, Westinghouse Electric Corporation

56-234. Relay Protection for the Ohio Valley Electric Corporation 330-Kv System. *H. C. Barnes, A. Hausburg, J. H. Kinghorn*, American Gas and Electric Service Corporation

56-235. Sleet Melting on 330-Kv Lines of American Gas and Electric Company and Ohio Valley Electric Corporation Systems. *C. F. DeSieno, C. A. Imburgia, G. H. McDaniel*, American Gas and Electric Service Corporation

9:30 a.m. Linear Circuit Theory

CP56-124. Nonsingular Transformation from Primitive to Network Equations. *N. B. Saunders*, Weston, Mass.

56-125. Some Mathematical Properties of Root Loci for Control-System Design. *F. M. Reza*, Syracuse University

56-126. Synthesis of Transfer Functions with Poles Restricted to the Negative Real Axis into Two Parallel R-C Ladders and an Ideal Transformer. *M. G. Malti*, Cornell University; *H. H. Sun*, Drexel Institute of Technology

CP56-127. Design of a Minimum Transmission Loss Tschebycheff 2-Pole Matching Network. *J. L. Dautremont, P. H. Rogers*, University of Michigan

56-128. Note on the Approximation Problem. *Norman, Balabanian*, Syracuse University

9:30 a.m. Instruments and Measurements

56-60. Galvanometer Efficiency as a Design Parameter. *F. K. Harris*, National Bureau of Standards

CP56-100. Advanced Design in a Small Clamp Volt-Ammeter. *R. F. Estoppey*, Weston Electrical Instrument Corporation

CP56-101. A Miniaturized Temperature Compensated Meter Rectifier. *E. L. Pagano*, Bradley Laboratories, Inc.

CP56-102. Differential Speed Indicator. *A. H. Wolfers*, Weston Electrical Instrument Corporation

9:30 a.m. Management

CP.* Effective Salary Administration. *C. J. Beller*, Cleveland Electric Illuminating Company

CP.* Systems Engineering Administration. *J. H. Rubel*, Hughes Aircraft Company

9:30 a.m. New Electron Tubes

56-86. Application of Statistical Techniques to Electron Tubes for Use in a 4,000-Mile Transmission System. *W. Van Haste*, Bell Telephone Laboratories, Inc. Re-presented for discussion

CP.* Design of a 5-Kw Ceramic Power Tetrode. *F. C. Johnstone*, Eitel-McCullough, Inc.

CP.* Microwave Applications of Gaseous Discharges. *P. E. Dorney*, Roger White Electron Devices, Inc.

CP.* Developments in the Retarding-Field Oscillator. *C. J. Carter, W. H. Cornetet, Jr.*, Ohio State University

CP.* Some Characteristics and Uses of Traveling Wave Tubes. *R. E. White*, Roger White Electron Devices, Inc.

9:30 a.m. Land Transportation

CP.* Modernization of Electric Equipment on Alco Diesel-Electric Locomotives. *J. F. Russell*, Alco Products, Inc.

CP.* Modernization During Factory Rebuilding of Diesel-Electric and Electric Locomotives. *K. O. Anderson*, General Electric Company

9:30 a.m. Telegraph Systems

CP.* Tests of Intercity Transmission of Teletypesetter Signals at 600 Words per Minute. *H. A. Rhodes*, American Telephone and Telegraph Company

CP.* Interconnection of Overseas and Domestic Teletypewriter Exchange Services. *D. S. Rau*, Radio Corporation of America Communications, Inc.

56-28. Simplified Printing Telegraph Switching and Integrated Data Processing. *J. B. Booth, R. H. Klick*, Teletype Corporation

CP.* Transistor-Type Printing Telegraph Transmitter-Distributor. *H. C. Isaacs*, Western Union Telegraph Company

9:30 a.m. Industrial Power Systems

56-129. Low-Voltage Switching and Protective Device Characteristics. *H. W. Huening, Jr.*, General Electric Company

CP.* 265/460 Volt Distribution System for New York Coliseum. *H. D. Kurt, L. E. Fisher*, General Electric Company

CP.* Selection of Utilization Voltages for Large Commercial Buildings with Primary Service. *D. Beeman, D. L. Johnson*, General Electric Company

CP56-130. Molded Case Circuit Breakers and Their Application in Commercial Buildings. *N. J. Schwartz*, Heinemann Electric Company; *J. B. Clapp*, General Cable Corporation

CP.* Fault Protection in Large Buildings Supplied by 265/460V Network. *J. De Lellis, A. J. Bisson*, Consolidated Edison Company of New York, Inc.; *William Deans*, I-T-E Circuit Breaker Company

CP.* Emergency Service for Commercial Buildings. *E. P. Peabody*, General Electric Company

9:30 a.m. System Engineering and Computers

56-163. Loss Evaluation—IV. Economic Dispatch Computers Principles and Application. *E. L. Harder*, Westinghouse Electric Corporation; *W. H. Osterle*, West Penn Power Company

56-57. Loss Evaluation—V, Economic Dispatch Computer—Design. *R. B. Squires, R. T. Byerly*, Westinghouse Electric Corporation; *H. W. Colburn, W. R. Hamilton*, West Penn Power Company

56-164. Digital Computer Solution of Power Flow Problems. *J. B. Ward, H. W. Hale*, Purdue University

56-18. The Use of Analogue Computers in Power System Studies. *J. E. Van Ness*, Northwestern University; *W. C. Peterson*, Michigan State University

1:45 p.m. Edison Medal Presentation to L. A. Umansky

Establishment of the Edison Medal. *E. P. Yerkes*, Chairman, Edison Medal Committee

Career of the Medalist. *F. M. Roberts*, Manager, Systems Application Engineering Section, General Electric Company

Presentation of Medal and Certificate. *President M. D. Hooven*

Response of the Medalist. *L. A. Umansky*

2:30 p.m. Section Representatives-Public Relations Forum

2:30 p.m. Insulated Conductors

56-70. Experimental 138-Kv Cable and Accessories. *Herman Halperin*, Commonwealth Edison Company

56-48. Guide to Joint Design for Rubber, Varnished Cambric, and Solid-Type Paper Insulated Cable. *J. E. Johnson*, Philadelphia Electric Company

56-71. Application of Polyethylene-Insulated, High-Voltage Power Cable in Chemical Plants. *S. J. Rosch*, Anaconda Wire and Cable Company

56-8. Current Rating of Aluminum Multiplex Cable. *L. F. Roehmann*, Kaiser Aluminum and Chemical Corporation

2:30 p.m. Relays

56-13. A Survey of Relay Test Methods. *Project Committee on Relay Test Methods*

56-165. Relay Protection of Motors in Steam Power Stations. *W. F. Neff*, Ohio Valley Electric Corporation; *S. H. Horowitz*, American Gas and Electric Service Corporation; *R. B. Squires*, Westinghouse Electric Corporation

CP.* New Thermal Overload Relay with Instantaneous Magnetic Trip on Faults. *C. A. Lister, W. L. Smith*, Electric Controller and Manufacturing Company

CP.* Application of Low-Voltage Switchgear for Motor Control. *E. W. Davis*, E. I. du Pont de Nemour and Company (Inc.)

2:30 p.m. General Basic Sciences

56-131. Electrical Formulas in Inch Units of Length. *J. W. Williamson*, Cleveland, Ohio

56-132. Properties of a D-C Arc in a Magnetic Field. *L. P. Winsor*, Rensselaer Polytechnic Institute; *T. H. Lee*, General Electric Company

56-133. Magnetic Effects of Compressional Stress at Low Field Intensities. *R. E. Fischell*, Naval Ordnance Laboratory

CP.* Economics of Multimillion Watt-Second Energy Storage. *H. C. Early*, University of Michigan

RADAR ANTENNAS on roof of building at U. S. Merchant Marine Academy to which a trip is scheduled during the Winter General Meeting for U. S. citizens only.

56-49 Analogue. Computer Synthesis and Error Matrices. *P. M. Honnell*, Washington University; *R. E. Horn*, Westnighouse Electric Corporation

2:30 p.m. Instruments and Measurements

56-25. An A-C Kelvin Bridge for the Audio Frequency Range. *B. L. Dunfee*, National Bureau of Standards

CP56-103. Wattmeter, Voltmeter, and Ammeter Bridge Circuit. *N. Vrana*, Cornell University

56-26. The Use of an A-C Bridge to Measure Core Loss at High Inductions. *I. L. Cooter, W. P. Harris*, National Bureau of Standards

56-104. Measuring 1.8 Million Kw Demand. *J. A. Morris, H. C. Thomas*, General Electric Company

CP.* A Voltage Dip Amplifier. *H. R. Lenz*, Philadelphia Electric Company

2:30 p.m. Safety

56-72. Electrostatic Explosion Controls in Hospital Operating Rooms. *Robin Beach*, Robin Beach Engineers Associated

56-6. Effect of Capacitor Discharges on the Heart. *W. B. Kouwenhoven*, The Johns Hopkins University

CP.* Emergency Power for Hospitals. *N. L. Griffin*, United States Department of Health, Education, and Welfare

CP.* Emergency and Exit Lighting in Theatres. *S. R. Todd*, City of Chicago

CP.* Throwover Equipment and Unit Equipment for Emergency Lighting. *Carl Ippolito*, Dual-Lite Company, Inc.

2:30 p.m. Land Transportation

56-105. An Air-Cleaning Blower for Ventilating Traction Equipment. *J. J. Gallagher*, General Electric Company

CP.* D-C High-Voltage Testing. *John Hewson, D. E. Stafford*

CP.* D-C High-Voltage Testing and Maintenance of D-C Traction Motors. *P. G. Lessmann, W. Schneider*, Westinghouse Electric Corporation

2:30 p.m. Telegraph Systems

56-106. Static Elimination on Bell System Teletypewriters. *H. Bovley*, Massachusetts Department of Labor and Industries; *D. B. Perry*, American Telegraph and Telephone Company; *B. S. Swezey*, Bell Telephone Laboratories, Inc.

56-107. Delay Distortion Correction. *W. D. Cannon*, Western Union Telegraph Company

56-108. A Flat-Bed Facsimile Telegraph Transmitter. *W. D. Buckingham*, Western Union Telegraph Company

CP.* Effect of Multipath Transmission on Facsimile Signals. *P. R. Marzan*, Times Facsimile Corporation

2:30 p.m. Electric Welding

56-109. Influence of Atmospheric Water Vapor on High-Current D-C Areas. *R. H. Benner, II*, Erlton, N. J.; *T. B. Jones*, The Johns Hopkins University

56-110. Cathode Instability in Argon Atmospheres. *H. C. Ludwig*, Westinghouse Electric Corporation

56-111. Let-Go Currents and Voltages. *C. F. Dalziel*, University of California; *F. P. Massoglia*, San Francisco Naval Shipyard

56-112. Inert Gas-Shielded Welding Arc Behavior and Metal Transfer Characteristics. *G. M. Skinner, D. M. Yenni*, Linde Air Products Company

2:30 p.m. System Engineering and Power Generation

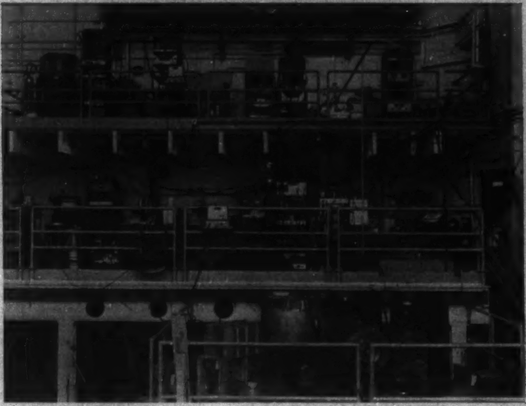
56-19. Evaluation of Unit Capacity Additions. *M. J. Steinberg, V. N. Cook*, Consolidated Edison Company of New York, Inc.

CP.* A New Automatic Dispatching System for Electric Power Systems. *B. R. Shepard, D. W. Halfhill, K. N. Burnett*, General Electric Company

CP56-166. Stability Considerations in Reactive Support Programs. *D. W. Spence, D. D. Nadkarni, J. E. Ziegler*, Syracuse University

2:30 p.m. Electrostatic Processes

CP.* Measurements of Charge Imparted to Fine Particles by a Corona Discharge. *G. W. Penney, R. D. Lynch*, Carnegie Institute of Technology



VIEW OF THE WEST FACE of the reactor at Brookhaven National Laboratory, Upton, Long Island, N. Y. Scheduled for visit on one of the Winter Meeting inspection trips.

CP.* The Charging of Small Particles for Electrostatic Precipitation. *G. W. Hewitt*, Westinghouse Electric Corporation

56-113. A New Technique for the Measurement of Corona Field Strength and Current-Density in Electrical Precipitation. *P. Cooperman*, Research-Cottrell, Inc.

CP.* Proposed Industry Standard for Electrostatic Precipitation Power Supply Equipment. *J. W. Farr*, General Electric Company; *G. R. Monroe*, Westinghouse Electric Corporation

56-114. Practical Applications of Electrostatic Phenomena to Particulate Matter. *O. C. Ralston*, Bureau of Mines

2:30 p.m. New Electron Tubes

CP.* Electrical Loss Problems Encountered in UHF Ceramic Tube Development. *R. L. Bailey*, General Electric Company

CP.* Hot Cathode Design for Gas Tubes. *S. Goldberg, K. J. Germeshausen*, Edgerton, Germeshausen and Grier, Inc.

CP.* A New Subminiature Thyratron for Airborne Applications. *H. J. Prager*, Radio Corporation of America

CP.* A New Micro-Miniature Ceramic Triode. *J. M. Connelly*, General Electric Company

Wednesday, February 1

9:30 a.m. Rotating Machinery Insulation

56-45. Experience and Development in Nondestructive D-C Testing for Maintenance of High-Voltage Stators. *A. W. W. Cameron, A. M. Sinclair*, The Hydro-Electric Power Commission of Ontario

56-51. Testing of Main Turbine-Generator Insulation. *J. E. Mulavey*, The Detroit Edison Company

CP.* Compatibility in Motor Insulation Systems. *H. R. Sheppard, G. L. Mullen*

CP.* Evaluation of Modified Silicone Insulation Systems and Motors. *H. R. Sheppard, G. L. Mullen*

9:30 a.m. Transmission and Distribution

56-3. Operating Experience with 14.4/24.9 Kv as a Rural Distribution Voltage. *W. M. Edmunds, L. B. Crann*, Rural Electrification Administration. Represented for discussion

56-167. 4-Kv Versus 13.8-Kv Distribution on the Boston Edison Company System. *L. J. Weed*, Boston Edison Company

56-168. Overhead Distribution at 4.16 Kv and 12.47 Kv in Urban Areas. *J. R. Oberholtzer, F. E. Sanford*, Commonwealth Associates, Inc.

56-169. Improve Existing 4-Kv Expand at 12 Kv. *G. A. Davis*, Southern California Edison Company

CP.* General Purpose Overhead Distribution Above 5 Kv. *W. R. Bullard*, Ebasco Services, Inc.

CP56-170. Higher Voltage Primary Distribution. *A. J. Pansini*, Long Island Lighting Company

56-171. Is Conversion to Higher Distribution Voltage Justified? *H. G. Dallas, J. W. Gallagher*, Philadelphia Electric Company

56-172. Use of Distribution Voltages Above 4 Kv. *E. V. Sayles*, Consumers Power Company

9:30 a.m. Power Generation

56-136. The Operations Recorder—A High Speed Printing Annunciator. *J. R. Leslie, G. M. Keyser*, The Hydro-Electric Power Commission of Ontario

56-137. Operation of Large Synchronous Generators in the Dynamic Stability Region with a Modern Amplidyne Voltage Regulator—Part I—Recommendations for Setting the Underexcited Reactive Ampere Limit. *R. A. Phillips, A. S. Rubenstein*, General Electric Company

56-138. Operation of Large Synchronous Generators in the Dynamic Stability Region with a Modern Amplidyne Voltage Regulator—Part II—Operating Tests and Analytical Studies. *K. R. McClymont, P. L. Dandeno*, The Hydro-Electric Power Commission of Ontario; *R. A. Phillips, A. S. Rubenstein*, General Electric Company

CP.* Fire Protection for Generating Stations. *Working Group on Fire Protection in Generating Stations*

9:30 a.m. Gaseous Dielectrics

CP.* On the Electric Breakdown of Electronegative Gases. *R. W. Crowe, J. C. Devins*, General Electric Company

CP.* Electric Breakdown of Gases and Vapors of Chlorofluorohydrocarbons. *C. N. Works, W. E. Lindsay*, Westinghouse Electric Corporation

CP.* The Effect of Solid Insulation and Contaminants on Gaseous Insulation in Insulation Structures. *G. Camilli, T. W. Liao*, General Electric Company

56-115. Calculation of Corona Starting Voltage in Air-Solid Dielectric Systems. *M. C. Halleck*, General Electric Company

CP.* Considerations for Corona Test Specifications. *C. W. Ross, E. B. Curdts*, J. G. Biddle Company

9:30 a.m. The Management of Co-operative Engineering Education Programs

CP.* Co-operative Education in the United States. *H. H. Armsby*, United States Office of Education

CP.* Philosophy and Operation of an Undergraduate Co-operative Program of Engineering Education. *J. A. M. Lyon, C. E. Watson,* Northwestern University

CP.* The Role of Elective Co-operative Programs in Modern Engineering Education. *S. B. Wiltse,* Rensselaer Polytechnic Institute; *E. M. Strong,* Cornell University; *E. W. Boehne,* Massachusetts Institute of Technology

CP.* An Industry View of Co-operative Engineering Education. *H. G. Hutson,* General Electric Company

9:30 a.m. Magnetic Computer Circuits—Analogue and Digital

56-134. Transcendental Function Analogue Computation with Magnetic Cores. *D. H. Schaefer, R. L. Van Allen,* United States Naval Research Laboratory

56-135. Special Purpose Magnetic Core Circuits. *R. D. Kodis,* Raytheon Manufacturing Company

CP.* Megacycle Magnetic Amplifiers. *T. H. Bonn, R. D. Torrey, J. P. Eckert,* Eckert-Mauchly Computer Corporation

CP.* Power Gain of High Frequency Series Pulse Magnetic Amplifiers. *R. D. Torrey, R. W. Spencer,* Eckert-Mauchly Computer Corporation

CP.* Logical Circuits with Pulse Magnetic Amplifiers. *B. K. Smith, W. H. Steagall*

9:30 a.m. Domestic and Commercial Applications

CP.* Serving the All-Electric Home. *W. R. New,* Tennessee Valley Authority

CP56-236. Heat as a Means of Air Purification. *J. C. Beckett,* Wesix Electric Heater Company; *C. E. Clifton,* Stanford University

CP.* Effect of Air Conditioning Loads on System Power Factor. *W. M. Penney,* Union Electric Company of Missouri

CP.* Panel Discussion—Electric Space Heating. *J. K. Goff,* Ceilheat, Inc.; *R. L. Boyd, Jr.,* Commercial Controls Corporation; *C. F. Kreiser,* Edwin L. Wiegand Company

9:30 a.m. Communication Theory

56-73. Introduction to Random Notes. *S. O. Rice,* Bell Telephone Laboratories, Inc.

CP.* Photographic Simulation of One Type of Bandwidth Reduction of Television Signals. *W. C. Morrison, K. Karstad, J. W. Tuska,* Radio Corporation of America Laboratories

56-74. Principles of Noise Reduction in Communication Channels. *L. S. Schwartz,* New York University

9:30 a.m. Industrial Power Rectifiers

56-44. Rectifier Power Supply for a Modern Rod Mill. *R. A. Buchanan, W. R. Hodgson,* Westinghouse Electric Corporation

56-173. Sealed Ignitron Principles Extended to Large Tubes. *J. L. Boyer, A. P. Colaiaco,* Westinghouse Electric Corporation

CP.* Application of Power Rectifiers to Regenerative Drives. *A. Schmidt, Jr., M. M. Morack,* General Electric Company

CP56-174. Service Life of Pumpless Ignitrons. *E. J. Remscheid,* General Electric Company

9:30 a.m. Radio Communications

CP.* Time Division Multiplex/ARQ. *A. Kahn, A. Liguori,* Radio Corporation of America Laboratories

CP.* Design and Application of Ruggedized Traveling Wave Tubes. *A. G. Peifer, W. N. Weber,* Federal Telephone and Radio Company

CP.* Radial Transmission Line Cavities—Nonsymmetrical Modes. *H. Haustad,* Federal Telephone and Radio Company

56-32. Standing-Wave-Ratio of Inaccessible Load. *C. Polk,* University of Pennsylvania

9:30 a.m. Light Amplifiers, Fluorescent Light Radio Interference, and Television Studio Lighting

CP.* Light Amplifying Phosphors. *F. E. Williams,* General Electric Research Laboratories

56-75. Evaluation of Radio Influence Voltages in Fluorescent Lighting Installations. *F. H. Wright, S. A. Zimmermann,* General Electric Company

56-76. Conversion of Studio Lighting from Black and White to Color Television. *P. W. Wygant,* Television Station WBAP-TV

CP.* Reduction of Television Studio Temperatures Using Heat-Control Coatings. *G. T. Howard,* General Electric Company; *A. F. Turner,* Bausch and Lomb Optical Company

2:00 p.m. Synchronous Machines and Insulation

56-12. On Some Poly-Field A-C Amplifiers. *E. Mishkin,* Polytechnic Institute of Brooklyn

56-175. The Theory of Anisotropic Field Structures in Synchronous Machines. *J. F. H. Douglas,* Marquette University

56-5. Physical Effects of Thermal Cycling on Stator Coil Insulation of Turbine Generators. *J. S. Johnson, J. C. Botts,* Westinghouse Electric Corporation. Re-presented for discussion

56-176. Corrections for Dielectric Absorption in High Voltage D-C Insulation Tests. *F. R. Schleif,* United States Bureau of Reclamation

56-177. A Statistical Method for Predicting Insulation Life from Experimental Data. *W. H. Horton,* Westinghouse Electric Corporation. Re-presented for discussion

2:00 p.m. Transmission and Distribution

56-178. Residential Distribution—An Analysis of Systems to Serve Expanding Loads. *S. B. Griscom, R. F. Lawrence,* Westinghouse Electric Corporation

56-179. Economic Comparison of Secondary Voltages, Single- and 3-Phase Distribution for Residential Areas. *R. A. Zimmerman, H. E. Lokay,* Westinghouse Electric Corporation

56-180. The Primary Service Unit System for Residential Distribution. *A. M. Lockie, H. B. Thacker,* Westinghouse Electric Corporation

56-181. Unbalanced Open-Wye Open-Delta Transformer Banks. *J. C. Neupauer,* Westinghouse Electric Corporation

56-182. Calculating and Factors Affecting Customer Minutes Outage in Radial Feeders. *R. A. Hamilton,* General Electric Company

2:00 p.m. Power Generation

CP56-144. Generator Field Tests in a One-Unit Hydro Plant. *H. O. Britt,* United States Bureau of Reclamation

56-145. Pump/Turbine Unit 2 Addition at TVA Hiwassee Hydro Plant. *L. R. Sellers, J. E. Kirkland, Jr.,* Tennessee Valley Authority

CP.* Alignment Tolerances for Vertical Hydroelectric Generators. *J. J. Hart,* Westinghouse Electric Corporation; *J. Fisch,* S. Morgan Smith Company

CP56-146. Economic Comparison of Steam Turbine Versus Motor Driven Boiler Feed Pumps. *A. G. Mellor, R. C. Muir, J. F. O'Mara, J. F. Ransom,* General Electric Company

2:00 p.m. Liquid Dielectrics

CP.* The Effect of Electrode Configuration on the Electrical Strength of Hexane. *A. H. Sharbaugh, E. B. Cox, R. W. Crowe, P. L. Auer,* General Electric Research Laboratories

56-139. Area Effect and Its Extremal Basis for the Electric Breakdown of Transformer Oil. *K. H. Weber, H. S. Endicott,* General Electric Company

CP.* The Effect of Hydrostatic Pressure and Applied Voltage Duration on the Breakdown Strength of Insulating Oil. *P. K. Watson,* National Research Council of Canada

CP56-140. Phenomena Accompanying Transient Low-Voltage Discharges in Liquid Dielectrics—II. Cathode Phenomena at Low Currents. *E. M. Williams, R. E. Smith,* Carnegie Institute of Technology

CP56-141. A New Technology of Insulating Oils of Petroleum Origin. *F. C. Doble,* Doble Engineering Company

2:00 p.m. Research

CP.* Research for the Electric Power and Electric Utility Industries in Sweden. *Ivar Herlitz,* Allmänna Svenska Elektriska Artiebolaget; *Gunnar Jancke,* Swedish State Power Board

CP.* Research by the Central Electricity Authority *J. S. Forrest,* Central Electricity Authority

CP.* Research in the Italian Electrical Industry *Edilio Passeris,* Societa Edison

CP.* Research for the Electric Power Industry in Japan. *K. Masai,* Central Research Institute of Electric Power Industry

2:00 p.m. New Curricula in Engineering Education

CP. A New Educational Program in Energy Conversion. *A. Kusko, D. C. White,* Massachusetts Institute of Technology

CP.* Course Content and Modern Aims in Electrical Engineering Education. *L. A. Finzi, E. R. Schatz,* Carnegie Institute of Technology

CP.* The Engineering Science Curriculum at The Pennsylvania State University. *E. A. Walker, W. K. Wilson,* The Pennsylvania State University

CP.* The Science Engineering Curriculum at the University of Michigan. *H. W. Welch, Jr.,* University of Michigan

2:00 p.m. Digital Computers—Circuits and Input-Output

CP.* Materials for High-Frequency Magnetic Amplifiers. *T. H. Bonn, C. M. Lipkin, Fred Bornstein,* Eckert-Mauchly Computer Corporation

56-142. Shifting Counters. *C. Eldert, H. J. Gray, Jr., H. M. Gurk, M. Rubinoff,* University of Pennsylvania

CP.* A Paper Tape Leader Using Germanium Photo Diodes and Transistor Amplifiers. *A. E. Slade, R. D. Potts*

56-21. Cyclic Decimal Codes for Analogue to Digital Converters. *J. A. O'Brien,* Radio Corporation of America

56-143. A New Five-Digit Plugboard System for Card-Programed Calculator. *S. B. Williams, N. M. Noonan,* General Electric Company

2:00 p.m. Marine Transportation

56-183. Aluminum for Marine Switchgear. *H. F. Harvey, Jr., E. J. Dawson,* Newport News Shipbuilding and Dry Dock Company

56-184. Shipboard Use of 400-Cycle Electric Power. *J. M. Apple, E. W. Lusby,* Navy Department

CP.* Complete Ship Wiring with Mineral Insulated Cable. *L. M. Goldsmith,* The Atlantic Refining Company

2:00 p.m. Radio Communications

CP.* An Explanation of Microwave Fading and its Correction by Frequency Diversity. *Henry Magnuski,* Motorola, Inc.

CP.* A Low Cost Microwave Radio Communications System. *C. N. Gillespie, D. W. Smith,* Raytheon Manufacturing Company

CP.* New Low Cost 960-Mc Multiplex Systems. *William Fingerle,* Budelman Radio Corporation

CP.* Microwave for the Telephone Industry. *W. C. Fisher,* Lenkurt Electric Company, Inc.

56-16. A 72-Channel Radio System for Toll Telephone Service. *M. C. Harp, M. H. Kebby,* Lenkurt Electric Company, Inc. Re-presented for discussion

2:00 p.m. Industrial Power Rectifiers

56-185. A New High-Power Cathode Circuit Breaker. *L. D. McConnell,* Canadian Westinghouse Company, Ltd.; *J. D. Findley,* Westinghouse Electric Corporation

56-186. Tests and Operating Experience with the Triple-Diametric Rectifier. *R. V. Wachter,* Aluminum Company of America; *C. S. Hague, C. R. Marcum,* Westinghouse Electric Corporation

56-187. Methods of Measuring Arc-Drop Voltage on Mercury-Arc Rectifiers. *H. Winograd,* Allis-Chalmers Manufacturing Company; *W. E. Lawton,* Aluminum Company of America. Re-presented for discussion

56-188. Harmonic Analysis by Direct Area Measurements. *I. K. Dortort,* I-T-E Circuit Breaker Company

CP56-189. A New Method for Reducing Arc-Back Currents in Rectifiers. *A. Schmidt, Jr.,* General Electric Company; *L. J. Harris,* Aluminum Company of America

2:00 p.m. Research and Chemical Industry—Part I—Research on Unconventional Energy Sources

CP.* Galvanic Fuel Cells. *Friedrich Kornfeil*, Signal Corps Laboratories

CP.* Nuclear Batteries. *William Shorr*, Signal Corps Laboratories

Part II—Panel Discussion of Cathodic Protection Energy Sources

CP.* Rectifiers with Impressed Current Anodes. *R. M. Wainwright*, University of Illinois; *J. P. Oliver*, National Carbon Company; *W. A. Luce*, Duriron Company

CP.* Sacrificial Anodes. *Bert Douglas*, Dow Chemical Company; *H. W. Wahlquist*, Ebasco Services, Inc.

Thursday, February 2

9:30 a.m. Synchronous Machines

56-190. The Design and Performance of Modern Large Turbine Generators. *B. M. Cain*, *Dean Harrington*, General Electric Company

56-53. Gap-Pickup Conductor Cooling of Turbine-Generator Fields; Ventilation Arrangements and Analysis of Performance. *D. M. Willyoung*, General Electric Company

56-191. Liquid Cooling of Turbine Generator Armature Windings. *C. E. Kilbourne*, *C. H. Holley*, General Electric Company

56-192. Operation of Large Steam Turbine-Generators. *J. H. Carter*, *R. E. Gorman*, General Electric Company. Re-presented for discussion

56-293. Operation and Maintenance of Hydrogen Systems for Turbine-Generators. *S. C. Barton*, *W. H. M. Olson*, General Electric Company. Re-presented for discussion

9:30 a.m. Transmission and Distribution

56-2. Planning Kilovars and Capacitors for the Southern California Edison System. *J. H. Drake*, *G. A. Davis*, Southern California Edison Company

55-711. D-C Circuit Gives Easy Method of Determining Value of Capacitors in Reducing I^2R Losses. *R. A. Schmidt*, General Electric Company. Re-presented for discussion

56-63. Pennsylvania Electric Company's Capacitor Program. *I. L. Phillips*, *F. M. Reed*, General Public Utilities System

56-193. Some Considerations in the Protection of High-Voltage Capacitor Banks. *N. R. Sheppard*, *N. R. Schultz*, General Electric Company

56-194. The Natural Frequency of Parallel Capacitor Banks. *W. H. Cuttino*, *Miles Maxwell*, Westinghouse Electric Corporation

56-17. Bibliography on Power Capacitors—1952–1954. *AIEE Working Group of the Capacitor Subcommittee*

9:30 a.m. Switchgear

56-33. High-Voltage Power System Fault Current Asymmetry. *M. J. Lantz*, Bonneville Power Administration

56-34. Calculation of Electric Power System Short Circuits During the First Few Cycles. *Report of Working Group on Circuit Breaker Application*

56-27. Calculated Symmetrical and Asymmetrical Short-Circuited Current Decrement Rates on Typical Power Systems. *Report of Working Group on Circuit Breaker Application*

9:30 a.m. Research and Education

S-82. Special publication, 80¢ to members, $1.60 to nonmembers

S-82. Needs and Supply of Engineers for Electric Utilities. *Frank Sanford*, Commonwealth Services, Inc.

S-82. Megawatts Versus Microwatts. *C. R. Joy*, *C. C. Boone*, Ebasco Services, Inc.

CP.* Engineers in Our Company. *Murray Joslin*, Commonwealth Edison Company

S-82. The Personal Problem of the Public Utilities in the Colleges. *J. D. Ryder*, Michigan State University

S-82. The Electrical Utility and the Student Enigneer. *J. S. Johnson*, Purdue University

9:30 a.m. Analogue Computer Applications and Developments

56-20. A Modern D-C Network Analyzer. *C. H. Hoffman*, Public Service Electric and Gas Company; *M. Lebenbaum*, Airborne Instrument Laboratories, Inc.

56-147. Linear Programing on an Electronic Analogue Computer. *I. B. Pyne*, Princeton University

56-148. Use of GEDA Analogue Computer in Generating Various Probability Distributions for Operations Research and "Monte Carlo" Applicators. *N. D. Diamantides*, Goodyear Aircraft Corporation

CP56-149. Electronic Analogue Solution of Free Surface Problems. *W. J. Karplus*, Los Angeles, Calif.

9:30 a.m. Metallic Rectifiers

56-77. High Temperature Selenium Rectifiers—A Survey of Manufacturers Data. *T. S. Shilliday*, Battelle Memorial Institute

56-78. Germanium Rectifiers for Industrial Applications. *L. W. Burton*, General Electric Company

CP.* Performance Analysis of Selenium Rectifiers at High Temperature. *N. F. Bechtold*, *E. W. Morris*, Signal Corps Engineering Laboratories

CP.* On the Dynamic Characteristics of Rectifiers. *Bruce Seddon*, General Electric Company

CP.* The Rectaloy Rectifier—An Improved Copper Oxide Device. *C. L. Meyer*, *K. E. Hassler*, *T. S. Shilliday*, Battelle Memorial Institute

9:30 a.m. World Television and Color Television

CP.* Television in the World Today. *C. J. Hirsch*, Hazeltine Laboratories

CP.* Color Television System Performance Requirements. *R. C. Kennedy*, National Broadcasting Company, Inc.

CP.* The Vitascan Live Flying-Spot Color Scanner. *J. H. Haines*, *G. R. Tingley*, Allen B. DuMont Laboratories, Inc.

9:30 a.m. Feedback Control

56-195. Two Types of Zero-Velocity-Error Servomechanisms. *E. Levinson*, Sperry Gyroscope Company

56-196. Block Diagram Transformations for Systems with One Nonlinear Element. *T. M. Stout*, Schlumberger Instrument Company

56-197. Analysis and Performance of a Valve-Controlled Hydraulic Servomechanism. *D. V. Stallard*, Massachusetts Institute of Technology

56-198. The Analogue Computer Study of an Application of a Phase-Space Type Predictor Control System to the Control of an Airframe. *A. M. Hopkin*, *Morimi Iwama*, University of California

9:30 a.m. Co-ordinating Committee No. 4

CP56-247. Problems of AIEE Standards Co-ordinating Committee No. 4 in Revising AIEE Standard No. 1. *A Progress Report of Co-ordinating Committee No. 4*

56-248. Guiding Principles in the Thermal Evaluation of Electrical Insulation. *L. J. Berberich*, *T. W. Dakin*, Westinghouse Electric Corporation

9:30 a.m. Symposium—Preventive Maintenance of Large Rectifier Substations in Electrolytic Plants

2:00 p.m. Synchronous Machines

56-199. Third Harmonic Voltage Generation in Salient Pole Synchronous Machines. *G. Angst*, *J. L. Oldenkamp*, General Electric Company

56-50. Harmonics of the Salient-Pole Synchronous Machine and Their Effects-Part I—MMF Harmonics Produced by the Armature and Damper Winding. *M. Liwschitz-Garik*, Polytechnic Institute of Brooklyn

56-1. Hunting of a Salient-Pole Synchronous Machine During Starting. *C. Concordia*, General Electric Company

55-56. A New Approach to the Calculation of Synchronous Machine Reactances—Part II. *M. E. Talaat*, Elliott Company

2:00 p.m. Transmission and Distribution

56-200. Potential of a Transmission Line Tower Top when Struck by Lightning. *E. F. Koncel*, Commonwealth Edison Company

56-201. Anomalous Flashovers on Transmission Lines. *C. J. Miller, Jr.*, The Ohio Brass Company

56-202. Switching Surges and Arrester Performance on High-Voltage Stations. *L. O. Barthold*, *I. B. Johnson*, *A. J. Schultz*, General Electric Company

56-203. Impulse Flashover of Combinations of Line Insulators, Air Gaps, and Wood Structural Members. *AIEE Lightning and Insulator Subcommittee*

CP.* Reduced Insulation in Power Systems. The Problem It Presents. *P. L. Bellaschi*, Portland, Ore.

2:00 p.m. Transformers and Computing Devices

56-79. Application of a Digital Computer to the Design of Power Transformers to Specification. *C. L. Moore*, *W. T. Duboc*, *P. A. Zaphyr*, Westinghouse Electric Corporation

CP.* The Use of Digital Computers in Transformer Design. *G. L. Tauscher*, Allis-Chalmers Manufacturing Company

56-59. Transformer Reactance Calculations with Digital Computers. *L. Rabins*, General Electric Company

56-80. Application of Digital Computers to Transformer Design. *S. B. Williams*, *P. A. Abetti*, *E. F. Magnusson*, General Electric Company

CP.* Digital Computer Design of Repetitive Manufacture Power Transformers. *J. C. Dutton*, *E. F. Magnusson*, General Electric Company

2:00 p.m. Symposium on Field Breakers

56-52. Introduction of Hydraulic Operation to Low-Voltage Air Circuit Breakers. *H. L. Peek*, *M. G. Dyer*, Allis-Chalmers Manufacturing Company

CP.* Application of Field Discharge Circuit Breakers to Electric Machines. *M. Temoshok*, *B. S. Beall III*, General Electric Company

CP.* Application of Main Field Breakers to Synchronous Machines. *R. F. Karlicek*, Westinghouse Electric Corporation

CP.* Application of Air Circuit Breakers to Excitation Systems of Salient Pole Synchronous Machines. *C. L. Killgore*, *H. O. Britt*, United States Bureau of Reclamation

2:00 p.m. Solid Dielectrics

56-150. The Surface Failure of Dielectrics. *L. J. Frisco*, *J. J. Chapman*, The Johns Hopkins Uhiversity

56-151. Tracking Resistance Test Methods. *M. W. Albright*, *W. T. Starr*, General Electric Company. Re-presented for discussion

CP.* Dielectric Effects Produced by Solidifying Certain Organic Compounds in Electric or Magnetic Fields. *W. McMahon*, Bell Telephone Laboratories, Inc.

CP.* Recent Developments in Polyethylene Insulating Materials. *J. A. Snyder*, *R. J. Lurie*, Bakelite Corporation

CP.* The Dielectric Properties of Polyethylene. *D. W. McCall*, Bell Telephone Laboratories, Inc.

2:00 p.m. Magnetic Amplifiers

56-204. The Operation of the Self-Balancing Magnetic Amplifier. *A. D. Krall*, *E. T. Hooper*, United States Naval Ordnance Laboratory

56-205. A Magnetic Amplifier Switching Matrix. *David Katz*, Bell Telephone Laboratories, Inc.

56-10. Analysis of Instability and Response of Reactors with Rectangular Hysteresis Loop Core in Series with Capacitance. *J. T. Salihi*, University of California

56-206. Hysteresis Loops in Dielectric Amplifiers. *Earl Wingrove*, General Electric Company; *L. Depian*, *W. L. Shevel*, Carnegie Institute of Technology

CP56-207. A Single-Transistor Magnetic-Coupled Oscillator. *Kan Chen*, Westinghouse Electric Corporation; *A. J. Schiewe*, Purdue University

2:00 p.m. Industrial Television and Broadcast Transmitters

CP.* Engineering in Television Installations. *J. W. Belcher*, General Precision Laboratories

CP.* A New Color Camera and Television System for Closed-Circuit Applications. *L. E. Anderson*, Radio Corporation of America

CP.* Electron Color Microscope. *J. J. Reeves*, Columbia Broadcasting System Laboratories

CP.* A 50-Kw Ampliphase Broadcast Transmitter. *T. J. Boerner*, Radio Corporation of America

2:00 p.m. Research

CP.* Need for Research in the Field of Fuels. *Eugene Ayres*, Gulf Oil Company

CP.* Electrochemical Cells as Energy Converters. *A. M. Adams*, Central Electricity Research Laboratories

CP.* Solar Energy—A Supplemental Energy Source. *H. B. Sargent*, American and Foreign Power Company

2:00 p.m. Feedback Control

56-208. Synthesis and Critical Study of Sampled-Data Control Systems. *E. I. Jury*, University of California

56-209. Factors in the Design of Digital Controllers for Sampled-Data Feedback Systems. *J. E. Bertram*, Columbia University

56-210. Digital Compensation of Continuous-Data Feedback Control Systems. *K. K. Maitra, P. E. Sarachik*, Columbia University

56-211. Synthesis of Feedback Control System by Gain-Contour and Root-Contour Methods. *V. C. Yeh*, New York University

2:00 p.m. Chemical Processes

CP.* The Gas Turbine—A Versatile Servant for the Process Industries. *W. R. Welon*, General Electric Company

CP56-14. Electrical Inspection of Petrochemical Plant Construction. *N. D. Casdorph, J. H. Wisting*, Carbide and Carbon Chemicals Company

CP.* Automatic Control in the Chemical Industry. *W. A. Crawford*, E. I. du Pont de Nemours and Company (Inc.)

CP.* Electricity and Titanium. *P. H. Vandenburgh*, Mallory-Sharon Titanium Corporation

CP.* Titanium Today. *H. B. Goodwin*, Battelle Memorial Institute

2:00 p.m. Electromagnetic Radiation from High Frequency Cables

CP56-288. Electromagnetic Radiation from Coaxial Cables Surface Transfer Impedance. *J. P. Quinn*, Rensselaer Polytechnic Institute

CP.* Analysis of Interference from Flexible Coaxial Cables. *A. V. Eastman*, University of Washington

CP.* Investigation of Measurement Techniques for the Shielding Effectiveness of Flexible Coaxial Cables. *O. D. Cosine*

CP.* Measurement of Energy Leakage from Radio Frequency Cables at VHF and Microwave Frequencies. *J. W. E. Griemsmann*, Polytechnic Institute of Brooklyn; *S. Greenblatt, L. Birenbaum*, New York Naval Shipyard

CP.* Radiation Fields from a Coaxial Shielding. *M. E. Taylor, E. R. Schatz*

Friday, February 3

9:30 a.m. D-C Machines

CP56-39. Determination of Stray Load Loss in D-C Machines. *R. L. Sieron*, Connecticut Light and Power Company; *D. A. Grant*, Worcester Polytechnic Institute

56-38. The Null Point Method of Commutation Adjustment. *S. J. Roumanis*, General Electric Company

56-36. On Wire Banding. *E. C. Appleby, P. G. Lassmann*, Westinghouse Electric Corporation

CP.* Basis and Background of the Proposed Revision of Test Code for D-C Machines, AIEE-501. *E. P. Smith*, General Electric Company

CP.* Revision of Test Code for D-C Machines, AIEE-501. *Report of D-C Machinery Subcommitee*

56-4. Determining the Parameters of a Short-Circuited Winding that Represents Eddy-Currents Paths. *K. A. Fegley*, University of Pennsylvania

9:30 a.m. Transmission and Distribution

56-212. Quantitative Relationships in Conductor Vibration Damping. *J. S. Tompkins*, Aluminum Company of America; *L. L. Merrill*, Stevens Institute of Technology; *B. L. Jones*, Jones-Hettelsater Construction Company

56-213. Progress Report on the Investigation of Galloping of Transmission Line Conductors. *A. T. Edwards, A. Madeyski*, The Hydro-Electric Power Commission of Ontario

CP56-214. Wind Tunnel Investigation of Conductor Vibration Using Rigid Models. *F. B. Farquharson, R. E. McHugh, Jr.*, University of Washington

56-215. An Economic Study of High-Voltage Transmission. *J. M. Henderson, A. J. Wood*, General Electric Company

56-216. Power Supply Development for the Atomic Energy Commission's Paducah Area Gaseous Diffusion Plant. *E. E. George*, Ebasco Services Inc.; *K. E. Hapgood*, Tennessee Valley Authority; *F. W. McCloska*, Sargent and Lundy

9:30 a.m. Transformers

56-62. The Performance of Transformer Oil Under Special Conditions. *W. E. Elliott, F. J. Vogel, D. N. Hiu*, Allis-Chalmers Manufacturing Company

CP.* A Study of the Co-ordination of Modern Lightning Arresters and Transformer Insulation. *E. J. Adolphson, F. J. Vogel*, Allis-Chalmers Manufacturing Company

56-54. Co-ordination of Dry-Type Transformer Models with Transformer Geometry. *L. C. Whitman*, General Electric Company

56-29. A Study of Models for Use in Evaluating Dry-Type Transformer Insulating System. *T. R. Walters, A. L. Scheideler*, General Electric Company

CP56-61. Silicones in Combination with Organic Based Materials for Use in Dry-Type Transformers. *H. M. Broderick, A. L. Scheideler, G. F. Simmons*, General Electric Company

9:30 a.m. Switchgear

56-47. A New Top Rating for the 161-Kv Oil Circuit Breaker with Multi-Break-Type Interrupters—15,000 MVA. *G. J. Easley, F. L. Reese*, Westinghouse Electric Corporation

56-40. Control of Voltage Gradients in High-Voltage, Watch Case, Multibreak Oil Circuit Breakers. *B. P. Baker, R. E. Friedrich*, Westinghouse Electric Corporation

56-217. A New Canadian Compressed Air Circuit Breaker. *C. C. Smith, D. H. McKeough*, Canadian Westinghouse Company, Ltd.

56-55. Development of a 3-Cycle High-Voltage Airblast Circuit Breaker with Interrupting Ratings up to 25,000 MVA. *H. E. Thommen, W. R. Streuli*, Brown Boveri Corporation

9:30 a.m. Thermal Evaluation of Magnet Wire

56-152. Magnet Wire Performance in Product Life Tests. *R. L. Balke*, General Electric Company. Represented for discussion

56-153. Thermal Evaluation of Enameled Magnet Wire. *J. F. Dexter*, Dow-Corning Corporation. Represented for discussion

CP.* Long-Range Heat Aging Tests on Alkanex. *W. W. Warham*, General Electric Company

CP.* Report on Results of Co-operative Test Program on Test Procedure for Evaluation of the Thermal Stability of Rectangular Magnet Wire. *Working Group Report*

CP.* The Thermal Classification of Enamelled Magnet Wire. *Working Group Report*

9:30 a.m. Magnetic Amplifiers

56-9. Full-Wave Bridge Magnetic Amplifiers with Inductive Loads. *H. H. Woodson*, Massachusetts Institute of Technology

56-218. Measurements on High-Speed Magnetic Servo Amplifiers with 2-Phase Motor Load. *W. A. Geyger*, United States Naval Ordnance Laboratory

56-219. Flux Reversal in Magnetic Amplifier Cores. *F. J. Friedlaender*, Purdue University

56-220. Low Impedance Operational Characteristics of Toroidal Cores Used in Magnetic Amplifiers. *C. L. Boyajian*, General Electric Company

CP.* Dynamic Core Behavior and Magnetic Amplifier Performance. *L. A. Finzi, D. L. Critchlow*, Carnegie Institute of Technology

9:30 a.m. Medicine and Biology

CP.* Control of Radio Interference from Medical Electronic Equipment. *A. L. Albin, H. M. Sachs*, Armour Research Foundation

CP.* The Use of Radio Frequency Power in Making Lesions in the Brain. *Saul Aronow*, Massachusetts General Hospital

CP.* Radar Radiation Health Hazard. *H. P. Schwan, Kam Li*, University of Pennsylvania

CP.* Radiation Monitoring Abroad the U. S. S. Nautilus. *M. E. Hayes*, Westinghouse Electric Corporation

CP56-23. Performance of a Large Area Photoconductive X-ray Pickup Tube. *J. E. Jacobs, Harold Berger*, General Electric Company

56-81. Physical Response Requirements of Pressure Transducers for the Reproduction of Physiological Phenomena. *E. H. Wood*, University of Minnesota. Re-presented for discussion

9:30 a.m. Wire Communications

56-240. Broad Objectives and General Description of the Type P1 Carrier System. *R. C. Boyd*, Bell Telephone Laboratories, Inc.

56-241. Application of Type P1 Carrier System to Rural Telephone Lines. *J. D. Howard*, American Telephone and Telegraph Company

56-242. Circuit and Equipment Descriptions of the Type P1 Carrier System. *E. K. Eberhart, F. J. Hallenbeck, E. H. Perkins*, Bell Telephone Laboratories, Inc.

56-243. Power Supplies for the Type P1 Carrier System. *D. H. Smith*, Bell Telephone Laboratories, Inc.

CP.* Field Trial Experience with the Type P1 Carrier System. *T. W. Thatcher, Jr.*, Bell Telephone Laboratories, Inc.

9:30 a.m. Industrial Control

56-82. Design of the Heavy Duty Electric Brake. *L. J. Parkinson*, General Electric Company

56-31. Interruption Tests on High-Voltage Air-Break Contactor. *C. A. Lister*, Electric Controller and Manufacturing Company

CP56-83. Analysis of the Shading Coil Magnet. *H. J. Kubiak*, University of Wisconsin

CP.* Applying Industrial Controllers for Safe Operation. *G. W. Heumann*, General Electric Company

56-84. A 2-Motor A-C Mine Hoist Control System. *A. H. Myles*, Electric Controller and Manufacturing Company

9:30 a.m. Electronic Circuits and Systems

56-84. Magnetic Trip Amplifier. *R. B. Hodson, E. W. Manteuffel*, General Electric Company

56-41. Transistor Voltage Regulator. *R. H. Spencer, T. S. Gray*, Massachusetts Institute of Technology

56-85. Magnetic Voltage and Frequency Regulator for an Aircraft Inverter. *E. W. Manteuffel*, General Electric Company

CP.* System Engineering for Guided Missile Installations. *J. Kraus*, Vitro Laboratories

CP.* A CW Radar Rate-of-Climb Meter for Vertical Take-off Aircraft. *S. H. Logue*, Convair, Division of General Dynamics Corporation

CP.* Micropower Operation of Silicon Transistors. *E. Keonjian*, General Electric Company

9:30 a.m. Electrothermal Processes

CP.* Transformers for Electric Furnaces. *E. F. Christensen, G. Kardsaen, Jr.*, General Electric Company

CP.* Electric Arc Furnace Controls. *C. W. Vokac*, Whiting Corporation

CP.* The Synchronous Condenser for Arc Furnace Loads. *S. E. McDowell*, Allis-Chalmers Manufacturing Company

CP.* Problems Associated with Arc Furnace Melting of Copper. *F. D. Shaw*, American Smelting and Refining Company

2:00 p.m. Computers in the Design of Machines and Systems

55-154. Synchronous Motor Starting Performance Calculation. *J. C. White*, General Electric Company

56-43. Fundamental Equations for Analogue Studies of Synchronous Machines. *D. B. Breedon, R. W. Ferguson*, Westinghouse Electric Corporation

56-155. A Digital Computer Program for Determining Atomic Wave Functions. *W. W. Piper*, General Electric Company

TURBINE-GENERATOR which is General Electric Company's 39 stage, 60,000-kw unit, installed in 1952 for the New York City Transit Authority's power plant at 59th Street.

2:00 p.m. Transmission and Distribution

56-221. Field Studies of Noise at Television Frequencies from Power Circuits. *J. R. Leslie, P. W. Waddington*, The Hydro-Electric Power Commission of Ontario

56-222. The Calculation of the Radio Interference Level of Transmission Lines Caused by Corona Discharges. *G. E. Adams*, General Electric Company

56-223. Variations in Radio and Television Interference from Transmission Lines. *H. H. Newell*, Worcester Polytechnic Institute; *F. W. Warburton*, New England Power Service Company

CP.* Relationship Between Corona and Radio Noise on Transmission Lines—Laboratory Studies—Part I—Point and Conductor Corona. *T. W. Liao*, General Electric Company

CP.* Application of Power System Harmonic Filters. *R. W. Ferguson, W. A. Munson*, Westinghouse Electric Corporation

2:00 p.m. Transformers

56-87. Methods for Measuring the "Q" of Large Reactors. *Chester Peterson, B. L. Dunfee, F. L. Hermach*, National Bureau of Standards

CP.* Switching Surges and Continuous Possibilities of Transformer Insulation. *W. C. Farneth, F. J. Vogel*, Allis-Chalmers Manufacturing Company

56-89. Controlled Temperature and Insulation Protection in the Operation of Power Transformers. *J. A. Klingensmith*, Westinghouse Electric Corporation

56-90. Leakage Reactance of Transformers. *A. A. Halacsy*, Jeffries Transformer Company

2:00 p.m. Switchgear

56-46. Short-Circuit Protection of Busway Systems with Current Limiting Fuses. *J. B. Cataldo, N. Shackman*, Bull Dog Electric Products Company

56-224. Use and Properties of Extruded High-Strength Aluminum for Electric Bus Conductors. *W. Switney, C. L. Carlson*, Westinghouse Electric Corporation

56-225. Vacuum Switches for Power Systems. *J. E. Jennings*, Jennings Radio Manufacturing Corporation; *A. C. Schwager*, Schwager-Wood Corporation; *H. C. Ross*, Jennings Radio Manufacturing Corporation

56-35. New Type Current Transformers for Low-Oil Content Circuit Breaker. *A. N. Arman*, Pirelli-General Cable Works, Ltd.; *W. H. Clagett*, Pacific Oerlikon Company

2:00 p.m. Thermal Evaluation of Insulation

CP.* Evaluation of Insulating Materials in Simple Combinations. *K. N. Mathes*, General Electric Company

CP.* A Fundamental Description of the Mechanical Behavior of Silicone Resins. *J. R. McLoughlin*, General Electric Company

56-157. Effects of Insulation Thickness on the Aging of Organic Insulation in Air. *L. C. Whitman, A. L. Scheideler*, General Electric Company

CP.* A Statistical Approach to Insulation Evaluation. *E. F. Seaman*, Department of Navy

2:00 p.m. Magnetic Amplifiers

56-226. A Signal Discriminating Magnetic Amplifier. *G. E. Lynn, J. F. Ringelman*, Westinghouse Electric Corporation

56-227. A Line Voltage Regulator Having Magnetic Amplifier Control. *F. W. Anderson*, Bell Telephone Laboratories, Inc.

CP56-30. The Pulse Stretch Coupling Circuit. *H. W. Patton*, Airpax Products Company

CP56-228. Core Volume Derivation for Magnetic Pulse Modulators. *J. E. Sunderlin*, Westinghouse Electric Corporation

CP56-229. Magnetic Frequency Multipliers and Their Rating—Part I—Frequency Triplers. *W. McMurray*, General Electric Company

2:00 p.m. Wire Communications

CP.* Objectives, Progress and Promises of Telephone Transmission. *H. R. Huntley*, American Telephone and Telegraph Company

56-244. Development of Transcontinental Communications in Canada. *J. W. Noyes, S. Bonneville, G. Gaudet*, Bell Telephone Company of Canada, Ltd.

56-245. A New Four-Channel Open-Wire Carrier System Employing Transistors. *R. S. Caruthers, W. S. Chaskin, H. K. Krengel*, Lenkurt Electric Company, Inc.

56-246. Experimental Modulator Wiring Using Coded Input. *R. F. Mallina*, Bell Telephone Laboratories, Inc.

2:00 p.m. Industrial Control

56-91. Magnetic Logic Circuits for Industrial Control Systems. *W. G. Evans, W. G. Hall, R. I. Van Nice*, Westinghouse Electric Corporation

CP.* Overcurrent Protection of Adjustable Speed D-C Motors Operating from Phase Controlled Rectifiers. *D. R. Kanitz, A. G. Mueller*, Square D Company

CP.* Proposed Standard for Electronic Motor Control. *Electronics Subcommittee*

56-15. An Automatic Output Regulator for Power Oscillators. *E. G. Hopkins*, New South Wales University of Technology; *H. J. Fraser*, Amalgamated Wireless Valve Company, Pty., Ltd.

2:00 p.m. Electronic Circuits and Systems

56-92. A Magnetic-Amplifier Simulator. *R. E. Fitts*, Rome, N. Y.

56-24. D-C Graphical Analysis of Junction Transistor Flip-Flops. *T. R. Bashkow*, Bell Telephone Laboratories Inc.

CP.* The Use of the Anodyne, Discussed as a Multiplier. *T. G. Calhoon, R. C. Shreckengost*, The Johns Hopkins University

CP.* Three-Dimensional Flight Simulator Power Supply. *E. P. Longerich*, Bendix Aviation Corporation

56-93. VHF Transistor Noise-Figure Test Set. *E. J. Burke*, General Electric Company

56-37. A Comparison of Three Common Emitter Transistor Servo Pre-amplifiers. *A. N. DeSautels*, Minneapolis-Honeywell Regulator Company

NIGHT VIEW of the Hazel blast furnace and cast house at U.S. Steel's Fairless Works near Morrisville, Pa. This is one of the trips scheduled for the Winter General Meeting.

(*Continued from page 68*)

rod mill where the copper bar is first heated and rolled into long lengths, the drawing operation where the rod is further drawn to the precise required size, tinning, stranding and insulating processes, vulcanizing, application of the fibrous braid, saturating, painting, printing, and inspecting.

Bell Telephone Laboratories, Murray Hill, N. J. (Thursday afternoon, February 2). This always popular trip is being presented again this year. In response to the committee's request, twice as many visitors than last year will be permitted. Highlights will be a showing of the repeater for the submerged telephone cable being laid in the North Atlantic Ocean, a demonstration of the Bell Solar Battery which converts light into electrical energy with some degree of efficiency, and at least one of the interesting machines for which Mr. Claude Shannon is famous.

New York City Transit Authority Power Plant, New York, N. Y. (Thursday afternoon, February 2). An unusual opportunity will be provided to see in close contrast the new and the old in generating equipment. A 7,500-kw cross-compound Corliss engine with its 35-ft diameter generator rotor represents the old, while the new equipment consists of a 60,000-kw high-pressure turbine with a hydrogen-cooled generator. An air-conditioned control room is a feature of this unique installation.

Ladies Entertainment

The committee has arranged an interesting program which includes a "Get Acquainted Tea" on Monday afternoon in the Washington Room at the Hotel Statler. On Tuesday a tour of Upper New York including the "Cloisters," a Luncheon and Bridge at the Engineering Woman's Club, and a dinner and floor show at night in the Penn Top with many attractive door prizes. For Wednesday a tour through the United Nations Buildings, Breakfast at Altman's, Luncheon and Fashion Show in the Cotillion Room of the Hotel Pierre on Thursday. Ladies must be registered with their husbands before signing up at Ladies Headquarters in the Washington Room, which will be open from 2:00 to 4:00 p.m. on Sunday, January 30th.

Engineering Societies Library Welcomes Members' Visits

Members and others attending the Winter Meeting of the Institute are especially invited to visit the Engineering Societies Library in the Headquarters building at 33 West 39th Street in New York City.

The Engineering Societies Library has an outstanding collection of electrical engineering literature. Its 170,000 volumes also cover all fields of engineering, primarily on the level of the graduate and practicing engineer. Student members find the Engineering Societies Library collection useful as it supplements those of the engineering schools.

The Reading Room of the Library is now open Mondays through Fridays, 10:00 a.m. to 9:00 p.m. and Saturdays 10:00 a.m. to 6:00 p.m. Why not take this opportunity to visit the Institute's Library to learn how it can serve you by mail, telephone, or telegraph, as well as in person?

Registration Fees

With this General Meeting, registration fees have been increased to $5 for members and $8 for nonmembers. However, nonmembers applying for membership in the Institute within 30 days will receive a $3 credit toward their entrance fee.

Winter General Meeting Committee

Members of the 1956 Winter General Meeting Committee are: A. J. Cooper, chairman; D. M. Quick, vice-chairman; J. J. Anderson, secretary, J. P. Neubauer, vice-president District 3, and budget coordinator; J. D. Tebo, chairman, Committee on Technical Operations; F. S Black, public relations; R. T. Weil, general session; Avery Gould, dinner-dance, D. V. Buchanan, hotel accommodations; J. V. O'Connor, inspection trips; Morris Brenner, registration; R. W. Gillette, smoker; R. R. Meola, monitors; S. Friend, Jr., theater and broadcast tickets; Mrs. Merwin Brandon, ladies' committee; C. T. Hatcher, ex officio member (past chairman).

Motor Applications Conference Attended by Over 200 in St. Louis

THE CONFERENCE on the Application of Motors to Heating and Cooling Equipment held in St. Louis, Mo., October 19–20, was attended by more than 200 representatives of the motor and air-conditioning industries. The Chase Hotel, headquarters for the conference, provided excellent facilities for the 2-day conference which was cosponsored by the Single Phase and Fractional Horsepower Subcommittee of the Committee on Rotating Machinery and the St. Louis Section of AIEE.

The General Session was called to order by R. F. Munier, general chairman of the conference. Mr. Munier introduced E. E. Gilcrease, chairman of the AIEE St. Louis Section, who gave the welcoming address which included a brief but very interesting history of St. Louis, the home of three nationally known motor manufacturers as well as several manufacturers of heating and cooling equipment.

Technical Sessions

The first technical session of the conference was devoted to papers by J. J. Mellon, Allen-Bradley Company, and R. E. Macherey, Square D Company, which described protective and starting equipment used with hermetic motors. Both papers included developments on the newer forms of equipment, for which design and tooling seems justified by the large volume of manufacturing developing as a result of central cooling unit installations. The authors gave details on the life requirements needed for control equipment applied to such installations.

The first paper of the second session was by W. A. Farquhar, Underwriters' Laboratories, Inc., and described the complete new equipment which has been installed in the Chicago Underwriters' Laboratories for testing window-type room air conditioners and other similar equipment, according to the provisions of the American Society of Refrigerating Engineers' Code and Underwriters' Laboratories' requirements. The objective of the Laboratories' testing program is to investigate safety characteristics and to determine conformity with other standards requirements. As pointed out in the discussion, the Laboratories activity does not include tunnel or other means of testing for determining air delivery or cooling capacity. Other papers of the second session related to motor design applications and testing. M. E. Evans, General Electric Company, provided a complete general analysis of the factors which govern hermetic compressor meter design, and showed how performance characteristics are influenced by design variations. The papers of R. F. Fricke, Westinghouse Electric Corporation, G. W. Horner and L. D. Jones, Century Electric Company, provided valuable data on air conditioner fan-motor characteristics, and gave details as to the means by which these characteristics could be co-ordinated with compressor motor characteristics. The paper of R. A. Strain, The Emerson Electric Manufacturing Company, provided a valuable historical discussion of surge testing of insulation, and made available for the records additional data and test method information.

The third session dealt closely with problems resulting from electrically driven space heating and cooling equipment. R. F. Scott, Southwestern Gas and Electric Company, Shreveport, La., presented a very interesting paper on the various forms of data to illustrate the severe impact on the electric power utilities from the recent widespread installation of air conditioning equipment. P. W. Wyckoff, Chrysler Corporation, presented a paper with quite a different suggestion for the identification and rating of hermetic compressor motors, and evoked considerable discussion by representatives of motor and air conditioner manufacturers. An interesting paper by G. S. Whitlow and A. J. Maixner, Union Electric Company, St. Louis, Mo., dealt with the heat pump and gave a thorough discussion of the authors' extensive experience and design of installations. H. E. Degler and Philip Oldberg, Jr., The Marley Company, discussed cooling tower motor application, a subject which has become prominent with the installation of domestic and commercial central cooling units.

The first paper of the fourth session by T. O. Pihl, Tecumseh Products Company, and A. P. White, Metals and Controls Corporation, presented data from recent investigations of the importance of the location of inherent protectors on hermetic com-

AT THE CONFERENCE (Left) on Application of Motors to Space Heating and Cooling Equipment were the Committee Chairmen (seated, l. to r.): J. L. Hamilton, retired, formerly with Century Electric Company, program; J. K. Howell, Westinghouse Electric Corporation, registration and reservations; Jack Roomy, General Electric Company, publicity; and C. S. Fall, C. S. Fall Company, finance. Back row (standing, l. to r.): W. E. Karsan, Allis-Chalmers Manufacturing Company, arrangements; and R. F. Munier, The Emerson Electric Manufacturing Company, general chairman. (In the right-hand picture, l. to. r.) J. L. Hamilton, retired, formerly with Century Electric Company, presiding chairman—Fourth Session; speakers R. P. Ballou, Howell Electric Motors Company; C. G. Veinott, Reliance Electric and Engineering Company; F. A. List, Westinghouse Electric Corporation; Miss L. M. Agacinsky, General Electric Company; A. P. White, Metals and Controls Corporation; L. D. Pihl, Tecumseh Products Company; and P. L. Alger, General Electric Company.

pressors in order to obtain a closer response of protector operation relative to motor winding temperature. The other papers of this session related to design and application of motors which had various other applications in addition to space heating and cooling equipment. F. A. List, Westinghouse Electric Corporation, presented a connection arrangement and described the performance characteristics of a type of motor which could have unlimited applications for heavy load requirements on farms. The paper by P. L. Alger and Miss L. M. Agacinsky (the one woman to attend the conference), General Electric Company, described a new method for part-winding starting which should be useful in many instances where the present methods are unsatisfactory. C. G. Veinott, Reliance Electric and Engineering Company, presented a paper which provided an alignment chart in nomograph form relating the characteristics of fan speed, input requirements, and air delivery. R. P. Ballou, Howell Electric Motors Company, described in detail the characteristics and applications of the torque motor.

Special Activities

A. C. Weber, Laclede Steel Company, addressed the Wednesday luncheon meeting on the subject "We Are in the Status Quo."

The Wednesday night banquet which was a joint meeting with the St. Louis Section, AIEE, was enhanced by the presence of the wives of conferees and members of the St. Louis Section. C. G. Arps, Allis-Chalmers Manufacturing Company, was the banquet speaker. His topic was "The Personal Equation."

"Persistance as Applied to Engineers and Engineering" was the topic chosen by O. L. Luft, Union Electric Company of Missouri, who addressed the luncheon meeting on Thursday.

Dinner Honors Soviet Engineers on 2-Week Tour of the United States

PROMINENT SOVIET ENGINEERS, Vladimire P. Loukine of the Machine Construction Ministry and Georgi P. Kazanski of the Collegium Radio-Technical Ministry, Moscow, U.S.S.R., were entertained at dinner in the Engineers Club on the evening of their departure for Moscow after a 14-day tour of the United States. The American Society of Mechanical Engineers (ASME), with Brigadier General S. E. Reimel, consultant, acted as host by request of the State Department. The dinner was attended by representatives of the AIEE; W. N. Wisely, secretary, American Society of Civil Engineers; E. O. Kirkendall, secretary, American Institute of Mining and Metallurgical Engineers; and C. E. Davies, secretary; and other representatives of the ASME. Mr. Logofet, U. S. State Department representative, acted as interpreter as well as Mr. Dudenkov of the Soviet Embassy in Washington, D. C.

As guests of ASME, Mr. Loukine and Mr. Kazanski spent 4 days touring the International Automation Exposition, ASME's Diamond Jubilee Meeting, R. R. Donnelly and Sons Company's printing plant, and the Commonwealth Edison Company Ridgeland Generating Station, as well as the Illinois Central Railroad Classification Yards, and Armour Meat Packing Company's plants in Chicago, Ill. Three days were also spent at Cleveland, Ohio, visiting the Standard Oil Refinery and the Ford Engine Plant. In Washington, D. C., the visitors attended the relay station of the American Telephone and Telegraph Company, Friendship Airport, National Academy of Sciences, the Lincoln Memorial, and Mount Vernon. While in New York, N. Y., the visitors went to the Institute of Radio Engineers (IRE), Tennessee Gas Transmission Company's construction work at White Plains, N. Y., Empire State Building, McGraw-Hill Book Publishing Company, and the Radio Corporation of America color television.

Preceding dinner, the visitors were introduced to a press conference by J. W. Barker, Fellow of AIEE and president of ASME, who expressed great pleasure to have as guests of the ASME and the State Department distinguished engineers from the U.S.S.R. Mr. Barker announced that the members of the United States team to visit Russia departing on December 4 were as follows: N. L. Bean, automatic transmission division, Ford Motor Company; W. H. Brandt, engineering manager, Westinghouse Electric Corporation, East Pittsburgh, Pa.; and A. C. Hall, general manager, research, Bendix Corporation, Detroit, Mich. In conclusion, Mr. Barker stated that he hoped the visitors would correspond with United States engineers in the future.

In the press interview, Vladimire Loukine expressed interest in automation and the precision control within close limits of

ON A 2-WEEKS' TOUR of American industrial plants, Vladimire P. Loukine (left) and George P. Kazanski (right), both of U.S.S.R., are shown with ASME President J. W. Barker (center) at dinner meeting for the visitors. An American delegation of engineers, bound for Russia as part of the exchange visits taking place between the two countries, has been named.

machine production. Mr. Kazanski was more interested in electronics and communications. In response to questions, Mr. Loukine explained that they were interested in automation to the maximum exclusion of manual labor and the extent to which feedback control in conjunction with precision gauging equipment was installed. He expressed regret that he did not see in the United States what he had hoped to see and this was explained on the basis that the trip was on short notice and adequate time was not allowed for the tour of the Ford engine plant in Cleveland. Mr. Kazanski was interested in the extent of the replacement of vacuum tubes by solid-state devices such as the transistor, magnetic amplifier, etc., and also expressed the view that the level of advancement in the U.S.S.R. was about the same as in the United States. On the tour, he found very few manufacturers of receivers using transistors because these are expensive and their use is confined more to measurement technique and particularly electronic control. Another interesting comment pertained to the development of miniature graphic panels which are used widely. The visitors did not see such miniature panels in operation. In regard to the Ridgeland Station inspection, the visitors had not seen any very modern and more up-to-date generating station than Ridgeland.

The visitors benefited considerably from the visit and it was hoped that the American team would likewise benefit when they toured the Soviet Union.

National Simulation Conference To Be Held in Texas, January 19–21

THE first National Simulation Conference, devoted to all types of simulation and associated computing techniques, will be held in Dallas, Tex., January 19–21 under the cosponsorship of the North Texas Section of AIEE, the Dallas-Fort Worth Chapter of the Institute of Radio Engineers (IRE) Professional Group on Electronic Computers, the Dallas-Fort Worth Section of IRE, and the Dallas-Fort Worth Chapter of the Association for Computing Machinery (ACM).

Hotel Reservations and Registration

Conference headquarters will be the Baker Hotel, Dallas. Persons attending the conference should make hotel reservations early, contacting the hotel directly. The name of the conference should be mentioned.

Registration will begin Thursday morning, January 19th, at 7:45 a.m. Registration fees are: $5, with registrants receiving a copy of the Proceedings containing all technical papers; $1 (optional for students only), with students choosing not to receive the Proceedings. Registrants will receive abstracts of all papers upon registration. Copies of the Proceedings may be ordered beforehand at $5 each from Professor F. W. Tatum, Southern Methodist University, Electrical Engineering Department, Dallas; make checks payable to the IRE.

Ladies Program and Tours

An informal women's program will be available for wives accompanying their husbands to the conference. The program will be available at the registration desk at the hotel.

Tours to one or two local analogue computer installations are planned for Friday evening, January 20, 1956. The complete details for the tours will be available on registration.

Conference Committee

Louis B. Wadel, Chance Vought Aircraft Inc., Dallas, is general conference chairman; technical program cochairmen are J. R. Forester, Chance Vought Aircraft, Inc., Dallas, and H. E. Blanton, Hycon Eastern, Inc., Cambridge, Mass.; secretary is C. C. Calvin, Chance Vought Aircraft, Inc., Dallas; treasurer is AIEE representative F. W. Tatum, Southern Methodist University, Dallas; and proceedings chairman is ACM representative B. B. Mackey, Chance Vought Aircraft, Inc., Dallas.

Thursday, January 19

Morning Session, 9:45 a.m.–12 Noon

Chairman: J. A. Green, John A. Green Company

Simulation of Military Vehicle Suspension Systems. *I. J. Sattinger, E. B. Therkelsen,* Willow Run Research Center, University of Michigan

Analogue Computer Computation of Propellant Linear Burning Rate. *A. I. Rubin,* Picatinny Arsenal

Electric Analogy to Transient Heat Conduction in a Medium with Variable Thermal Properties. *D. R. Otis,* Oak Ridge

Application of GEDA Analogue Computers to Study Temperature Transients in a Plastic Windshield. *P. J. Hermann,* Goodyear Aircraft Corporation

Afternoon Session, 2:00 p.m.–5:30 p.m.

Chairman: J. W. Ludwig, Chance Vought Aircraft, Inc.

Performance Requirements for Flight Tables. *H. E. Blanton,* Dynamic Analysis and Control Laboratory, Massachusetts Institute of Technology

The Use of the Bendix Flight Table. *E. J. McGlinn,* Research Laboratories, Bendix Aviation Corporation

The Design of a High Performance Hydraulic Servo. *M. S. Feder, K. V. Bailey,* Research Laboratories Division, Bendix Aviation Corporation

Flight Simulator for Acoustic Homing Torpedoes. *C. G. Beatty,* USNOTS, Pasadena

Laboratory Evaluation of Systems Incorporating Scanning Reticles. *H. H. Kantner, S. H. Cameron,* Armour Research Foundation, Illinois Institute of Technology

Optical Simulation of Radar. *W. Blitzstein, T. Levine,* Moore School of Electrical Engineering, University of Pennsylvania

High Accuracy Operational Digital Simulation. *J. Tou,* Moore School of Electrical Engineering, University of Pennsylvania

Friday, January 20

Morning Session, 9:00 a.m.–12 Noon

Chairman: W. L. Evans, Convair, Fort Worth

Dynamic Tester Tape Preparation on ORDVAC. *G. A. Beck,* Ballistic Research Laboratories

A Comparative Evaluation of Several Methods for Achieving Greater Angular Accuracy in Search Radars Using Simulation Techniques. *C. M. Walter,* A. F. Cambridge Research Center

The Derivation of Simulators of Gas Turbine and Other Physical Systems from Experimental Data. *L. Wolin,* Naval Air Experimental Station, Pa.

The Uses of Post-Flight Simulation in Missile Flight Analysis. *R. G. Davis,* U. S. Naval Ordnance Laboratory, Calif.

Substitution Methods for the Verification of Analogue Computer Solutions. *H. F. Meissinger,* Hughes Aircraft Company

Analogue Computer Prepatch Logic Using Sub-Routines. *W. J. Wachter,* University of Pennsylvania

Afternoon Session, 2:00 p.m.–5:00 p.m.

Chairman: W. W. Koepsel, Southern Methodist University

An Approach to Digital Simulation. *M. Palevsky,* Computer Division, Bendix Aviation Corporation

The Simulation of a Digital Differential Analyser on the IBM 701. *B. M. Tostanoski, C. J. Hoppel, M. M. Dickinson,* International Business Machines Corporation

The Simulation of a Proposed Airborne Digital Computer on the IBM 701. *J. R. Belford, M. E. Maron,* International Business Machines Corporation

A Simulator for Analysis of Sampled Data Control Systems. *P. K. Giloth*, Bell Telephone Laboratories, N. J.

General Evaluation of a Linear Time-Variant System. *J. M. Gallagher, Jr.*, Dynamic Analysis and Control Laboratory, Massachusetts Institute of Technology

Design of a Non-Linear Control System with Random Disturbances. *K. B. Tuttle*, Northrop Aircraft, Inc.

Evening

Tours to local computer installations

Saturday, January 21

Morning Session, 9:00 a.m.–12 noon

Chairman: C. F. Seay, Jr., Collins Radio Company

Time Domain Network Synthesis for an Analogue Computer Setup. *J. Otterman*, University of Michigan

Simulation of Dead Time. *N. L. Irvine*, Aerojet General Corporation

A Simulation System for the Study of Human Dynamics. *J. M. Stroud*, U. S. Navy Electronics Laboratory, Calif.

The Applied Systems Development and Evaluation Center at the Navy Electronics Laboratory. *R. Coburn*, U. S. Navy Electronics Laboratory, Calif.

An Analogue Computer for Radioactive Fallout Prediction. *H. K. Skramstad, J. H. Wright*, National Bureau of Standards

An Exponential-Process Analyzer and Synthesizer. *J. R. Macdonald*, Texas Instruments, Inc.

Afternoon Session, 2 p.m.–5:00 p.m.

Chairman: J. R. Macdonald, Texas Instruments, Inc

The Gated Amplifier Computer Technique. *S. Godet*, Reeves Instrument Corporation

A Wide-Band Direct-Coupled Operational Amplifier. *C. S. Deering*, Convair, Ft. Worth

An Improved Diode Function Generator for Analogue Computers. *R. A. Bruns*, Jet Propulsion Laboratory, California Institute of Technology

Use of Semi-Conducting Surfaces in Analogue Function Generation. *V. L. Larrowe, M. Spencer*, Willow Run Research Center, University of Michigan

Repeatable Generation of Noise with a Masked Cathode Ray Tube. *L. B. Wadel, C. C. Calvin, J. W. Atkins, Jr.*, Chance Vought Aircraft, Inc.

A Comparison of Diode Switching Methods for Analogue Function Generators. *O. L. Updike, J. H. McLeod, Jr.*, USNAMTC, Pt. Mugu, Calif.

1955 Index

The Index for Volume 74 of *Electrical Engineering*, 1955, is bound into this issue following "Institute Activities."

Anyone desiring a separate reprint of this Index for binding purposes, can obtain one free of charge by writing to the Order Department, AIEE, 33 West 39th Street, New York 18, N. Y.

Aircraft Engineers Attend Annual Technical Conference

THE ANNUAL TECHNICAL CONFERENCE on Aircraft Electrical Applications was held October 25–27 at the Hollywood Roosevelt Hotel in Los Angeles, Calif., with 425 engineers in attendance. Presented during the 3-day conference were 23 technical papers, resulting in a thorough coverage of new ideas and developments in the field. The subject of reliability was stressed both in the papers and the discussions that followed.

A luncheon was held on the second day with Brigadier General Leighton I. Davis, Commander, Holloman Air Development Center, as guest speaker. He spoke on the subject of reliability as it pertains to missile flight performance. He cited several examples of problems encountered in testing missiles at the Holloman Air Development Center, which were due to component failures. It was brought out that although individual components may be 98 per cent or 99 per cent reliable in themselves, when placed together in a missile the probability of a successful flight is reduced to approximately 10 per cent or less. In a missile the absence of a pilot to make decisions in times of emergency was emphasized. With no person to select an alternate power source or to correct improper flight attitude, etc., extreme reliability of all components are necessary if successful flights are to be accomplished. General Davis closed his remarks with a brief discussion of the value of parallel development programs and "compressed time" research schedules.

The technical session was divided into three broad categories—"Components and Equipment," "Management and Laboratory," and "Power Systems." On the first day the presentation of papers and discussion on components brought forth new ideas including a transistorized overvoltage relay and a glow switch for a-c overvoltage protection. Other subjects covered the thermal and electrical characteristics of blast-cooled generators, the effect of vibration on switch terminations, a discussion of temperature controllers for windshield anti-icing, and sensing methods applicable to 3-phase load transfer contactors.

The morning session of "Management and Laboratory" consisted of three papers covering the organization and management of the engineering department of an equipment airline, and an aircraft manufacturer. These papers gave the audience an excellent insight into the problems encountered in engineering management in the three major phases of the aircraft electrical industry. Although the prime purpose of the engineering departments vary in that the airline department provides technical assistance as required to maintain the airplane in a safe operating condition, and the equipment and aircraft manufacturers have the task of anticipating and keeping up with the market, all are faced with the basic problem of attracting and retaining talent and providing an atmosphere conducive to the maximum development of the individual's potential.

Three papers relating to laboratory and test facilities and methods thoroughly covered the requirements for evaluating a-c electric systems, an airline-operated engineering test center, and a simplified test method for the d-axis transient reactance and time constant.

The subject of alternating current "power systems" and the problems involved is of current interest to nearly all engineers engaged in the aircraft electrical field. Nine papers were presented on this subject.

RECENT TECHNICAL CONFERENCE on Aircraft Electrical Applications at the Hollywood Roosevelt Hotel, Los Angeles, Calif. was attended by a group that included (back row, l. to r.): F. L. Lyons, conference chairman; Lee R. Larson, chairman of the Committee on Air Transportation which sponsored the conference; and W. L. Berry, past chairman. Front row (l. to r.): H. F. Rempt, luncheon chairman, Lieutenant Colonel J. P. Stapp, Air Research and Development Command, and Brigadier General L. I. Davis, Commander of the Holloman Air Development Center, luncheon speaker.

F-7V Cutlass flying over Dallas, Tex.

"Electricity in Aircraft" Is Theme of Texas South West District Meeting

PLANS ARE NEARING COMPLETION for the South West District meeting, which will be held in Dallas, Tex., April 2–4, 1956, with headquarters at the Baker Hotel. A broad program of diversified technical sessions, inspection trips, social events, and ladies' entertainment is promised for the 1,200 to 1,500 members who are expected to attend.

Since the second largest aircraft producing area in the United States is centered in the Dallas–Fort Worth area, it is particularly fitting that "Electricity in Aircraft" be the theme of the Dallas meeting. For the first time in the history of AIEE, exhibits will be an attraction at a District meeting. There will be 60 exhibit booths in the Crystal Ballroom of the Baker Hotel, displaying the latest airborne electric apparatus, components, and support items.

A full and varied technical program has been arranged in three concurrent sessions. These meetings of Aircraft, Power Transmission and Distribution, and Industrial sessions will appeal to engineers in the aircraft and utility fields, as well as the oil, chemical, and manufacturing groups in the Southwest. Full details will appear in the March 1956 issue of *Electrical Engineering*.

Approximately 400 senior electrical engineering students are expected to attend the meeting. The student program will consist primarily of the Annual Student Branch Paper Competition. The competition will be held at such a time that it will not interfere with the technical sessions in order that all students may have an opportunity to attend the various District meeting technical paper sessions, field trips, and exhibits.

Social Activities

An elaborate Dinner-Dance on Tuesday night, April 3, heads the social docket. Extravagant headliner entertainment will highlight the evening's events.

Ladies' Activities

The wives attending this meeting have an interesting schedule of social events awaiting them, including a "Get-Acquainted" coffee at the Statler-Hilton ballroom, a brunch style show in the Zodiac Room of the Neiman-Marcus store, a book review and luncheon at the Dallas Athletic Club Country Club, with optional activities of organized or informal tours of the points of interest in Dallas. Mrs. Estes Thompson and her committee of Dallas and Fort Worth women have arranged a suite at the Baker Hotel, to be open for the ladies all during the meeting for coffee, cards, and conversation.

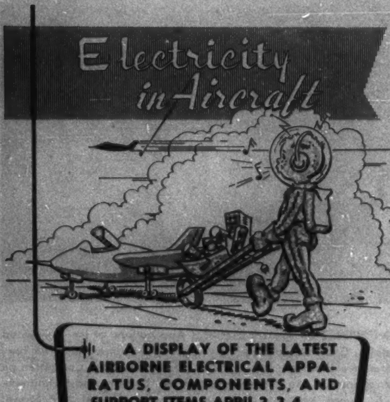
Inspection Trips

Dallas Power and Light's Parkdale outdoor power plant, Chance Vought, Bell Aircraft, Texas Instruments, and the Republic Bank Building will be visited on organized tours.

Hotel Accommodations

Blocks of rooms have been reserved at the Baker, Adolphus, and Statler-Hilton Hotels for members and guests. Requests for reservations should be sent directly to the hotel, with mention of attendance at the AIEE District Seven Meeting.

Additional information regarding the meeting may be obtained by writing George A. Smith, Jr., General Chairman, AIEE District Seven Meeting, Central Station Alarm, 610 North Akard Street, Dallas, Tex.


Electricity in Aircraft
A DISPLAY OF THE LATEST AIRBORNE ELECTRICAL APPARATUS, COMPONENTS, AND SUPPORT ITEMS APRIL 2, 3, 4, 1956

THIS IS THE COVER from an announcement of an aircraft industry exhibition to be held with the Seventh District Meeting on April 2–4, 1956, in Dallas, Tex. Such an exhibit is particularly appropriate for the South West District as this is the nation's second most important aircraft production area. For additional information, write to Mr. J. R. Duff, Box 11041, Fort Worth, Tex.

ASME Announces Recipient of the Hoover Medal

The Hoover Medal Board of Awards named Charles F. Kettering, research consultant and director of General Motors Corporation, as the 1955 recipient of the Hoover Medal "...for great, unselfish, nontechnical services." The Board consists of representatives of the four Founder Societies: AIEE, American Society of Mechanical Engineers (ASME), American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers. Mr. Kettering was awarded the medal at the ASME Honor Luncheon in Chicago in November during that organization's Diamond Jubilee Annual Meeting celebration.

Dr. Kettering, who is now retired, was vice-president of General Motors Corporation, and general manager of their research laboratories division. In 1927, he founded the Charles F. Kettering Foundation, which he now serves as chairman of the board. He is director of the Sloan-Kettering Institute for Cancer Research. He is an AIEE Fellow and has served on the Lamme Medal Committee (1928–29).

Paper and Pulp Conference Scheduled for Florida in March

THE AIEE'S CONFERENCE on Electrical Engineering as Applied to the Paper and Pulp Industry has been scheduled for March 8 and 9, 1956, at the University of Florida in Gainesville.

The conference will be jointly sponsored by the AIEE Paper and Pulp Industry Subcommittee, the Jacksonville, Florida Section of AIEE, and the College of Engineering of the University of Florida.

Of interest to all persons associated with the paper and pulp industry, ten important papers will be presented during the three sessions of the 2-day conference. Among the subjects to be discussed are: the use of atomic energy in industrial plants; the use of television in the paper and pulp industry; the problems in adaptation of electrical engineering to the paper industry; and the conduit problems and their solutions in paper mills.

Open forum discussion periods have been arranged at each session, and the conference program will be concluded with an inspection trip of the University of Florida's paper and pulp department.

Presiding at the first session of the conference will be S. A. Bobe of Westinghouse Electric Corporation, Atlanta, Ga., who is chairman of the AIEE Paper and Pulp Industry Subcommittee. H. M. Reed, Jr., of International Paper Company, Mobile, Ala., will preside at the second session, while E. K. Murphy of Rayonier, Inc., New York, N. Y., will preside at the third session. The welcoming address at the conference will be given by Dean J. Weil of the University of Florida's College of Engineering.

The tentative technical program follows:

Thursday, March 8

9:00 a.m. Registration at Engineering Building

10:00 a.m. Morning Session

Chairman: S. A. Bobe, Westinghouse Electric Corporation

Welcoming Address: Atomic Energy—Its Importance in Industry. *Joseph Weil*, University of Florida's College of Engineering

Co-operation Between Industry and Engineering Colleges. *C. W. Drake*, University of Florida

11:05 Recess

Problems in Adaptation of Electrical Engineering to the Paper Industry. *M. W. Matthews*, International Paper Company

11:45 Discussion

12:30 Luncheon at Dining Hall

Speaker: I. Y. East, Southern Kraft Division, International Paper

2:30 p.m. Afternoon Session

Chairman: H. M. Reed, Jr., International Paper Company

Use of Television in the Paper and Pulp Industry. *G. I. Burner*, Rust Engineering Company

Applications of the New NEMA D-C Motor Ratings to the Paper Industry. *K. P. Grenfell*, General Electric Company

Electrical Load and Frequency Control in Captive Power Plants. *W. H. Sisson*, Minneapolis-Honeywell Regulator Company

4:45 p.m. Open Discussion

6:30 p.m. Social Hour at Thomas Hotel

7:30 p.m. Banquet at Thomas Hotel

Friday, March 9

9:30 a.m. Morning Session

Chairman: E. K. Murphy, Rayonier, Inc.

Regenerative Braking Winder Drives. *M. H. Fisher*, Westinghouse Electric Corporation

Adjustable Controlled Tension for Shaft Driven Windup and Rewind Drives in the Paper Industry. *L. T. Christensen*, Dynamatic Company

10:50 a.m. Recess

Xatron Speed Regulated Drives as Applied to the Paper Industry. *R. T. Willard*, Reliance Electric and Engineering Company

Conduit Problems and Their Solutions in Paper Mills. *V. S. Oakes*, Hammermill Paper Company

12:30 p.m. Lunch

2:30 p.m. Inspection Trip: University of Florida, Paper and Pulp Department

Eta Kappa Nu Award and Honorable Mention Winners for 1955

THE ETA KAPPA NU AWARD DINNER will be held in the Keystone Room of the Hotel Statler, New York, N. Y., January 30th, during the AIEE Winter General Meeting. At this time, the Eta Kappa Award for the "Outstanding Young Engineer of 1955" will be presented to W. E. Chope, and Honorable Mention citations will be given to J. N. Grace, H. R. Johnson, D. B. Shuster, and Glen Wade.

Mr. Chope was declared the winner of the award "...by virtue of his noteworthy achievements in the field of nucleonics, and his deep interest in the welfare of his fellow men." Mr. Chope was born on June 11, 1923, in Louisville, Ky. He received an electrical engineering degree from Ohio State University in 1948, and a master's degree in engineering and business administration from Massachusetts Institute of Technology in June 1949. After working with H. H. Scott Radio Company and Tracerlab, Inc., in 1950 he organized the Industrial Nucleonics Corporation, of which he is now president and director. The AccuRay process control system manufactured for this company was invented and designed by him. He has been active in World Neighbors, Inc., from its inception and is now chairman of the national executive committee. He was selected "Outstanding Young Man of 1952" by the Columbus Junior Chamber of Commerce and received the "Distinguished Service Award for the State of Ohio" in 1953. He is member of the AIEE Board of Trustees of the Ohio Society of Professional Engineers, Eta Kappa Nu, Tau Beta Pi, Institute of Radio Engineers, and American Institute of Manufacturers.

W. E. Chope

J. N. Grace will receive the Eta Kappa Nu Honorable Mention Citation "...by virtue of his outstanding contributions to the development of atomic power, and his exceptional activity in civic and professional affairs." Mr. Grace was born May 27, 1924, in Pittsburgh, Pa. He attended Carnegie Institute of Technology, receiving a bachelor of science degree in 1949 and a doctor of science degree in 1951. He has been employed by the Westinghouse Research Laboratories since 1949 and is presently supervisory scientist in charge of the reactor and plant kinetics section of the physics department. He has written several papers on analogue computer theory, reactor stability, and control systems for nuclear power plants. He is a member of AIEE and the Institute of Radio Engineers, and served as program chairman, Pittsburgh Section, and is a member of the American Nuclear Society. He was the recipient of the Tau Beta Pi Fellowship in 1949 and the Gerard Swope Fellowship in 1950. He is a member of Eta Kappa Nu, Sigma Xi, Tau Beta Pi, and Pi Mu Epsilon.

H. R. Johnson will receive the Eta Kappa Nu Honorable Mention citation "...by virtue of his distinguished research in microwave tubes, and his active participation in community organizations." Mr. Johnson was born April 26, 1926, in Jersey City, N. J. He attended Cornell University, graduating in 1946, and received a doctors degree in physics from Massachusetts Institute of Technology in 1952. He was an instructor at Cornell University and was appointed research assistant at MIT. He is at present a senior member of the technical staff, and head of the microwave tube section at Hughes Research Laboratories,

HONORABLE MENTION
Eta Kappa Nu

J. N. Grace

H. R. Johnson

D. B. Shuster

Glen Wade

Culver City, Calif. Mr. Johnson has written many papers on microwave spectrum and associated devices. He is a member of AIEE, Eta Kappa Nu, Tau Beta Pi, Phi Kappa Phi, Sigma Xi, and the Institute of Radio Engineers.

D. B. Shuster will receive the Eta Kappa Nu Honorable Mention citation "...by virtue of his notable contributions to the art of antiaircraft warfare, and his wide interest in cultural and social life of his community." Mr. Shuster was born July 17, 1923 in Santa Fe, N. Mex., and attended the New Mexico Military Institute. He has worked with Sandia Corporation since 1946 and is presently a departmeht manager. He has been continually engaged in developing means for measuring performance of atomic weapons systems. He perfected a high-time-resolution telemetering system, a multichannel telemetering system which would work within the confines of an artillery shell, and a high-gain, wide-band receiving antenna array for air-to-ground radio telemetering. Much of his other work is classified.

Glen Wade will receive the Eta Kappa Nu Honorable Mention citation "... by virtue of his exceptional contributions to the microwave research, and his unselfish service to his church." Mr. Wade was born March 19, 1921, and attended the University of Utah from which he graduated in 1948 first in his class. He received a master's degree from Utah in 1949, and a doctors degree from Stanford University in 1954. He taught at Utah and Stanford, and worked at the Naval Research Laboratory and the General Electric Microwave Laboratory. He is presently a research associate at the applied electronics laboratory, Stanford University. Mr. Wade has written many papers dealing with microwave noise and traveling wave tubes. He is a member of Tau Beta Pi, Phi Kappa Phi, Sigma Xi, and the Institute of Radio Engineers.

AIEE Papers Presented at the Nuclear Congress

The sessions of the Nuclear Engineering and Science Congress held in the Public Auditorium, Cleveland, Ohio, December 12–16, 1955 in conjunction with the International Atomic Exposition, in which AIEE sponsored papers were presented are listed. To order these papers, and any others on the program of over 300 contributions, orders should be sent directly to: The American Institute of Chemical Engineers, 25 West 45th Street, New York 36, N. Y. Prints are 30 cents each and should be ordered by number only. A complete set of the papers, comprising over 280 individual papers, is $65 per set. For copies to be delivered in New York, N. Y., 3% city sales tax should be added. AIEE sponsored papers that were presented at the Congress are listed.

Research Reactors and Radiation Laboratories

Chairmen: Manson Benedict and H. J. Gomberg

154. Neutron Lifetimes and Void Coefficients for Research Reactors. *T. H. Pigford, Marius Troost, J. R. Powell, Manson Benedict,* Massachusetts Institute of Technology (AIChE)

155. Ford Nuclear Reactor and Phoenix Memorial Laboratory. *R. B. Mesler, W. K. Luckow, H. J. Gomberg,* University of Michigan (AIChE)

357. Control System for Research-Type Nuclear Reactors. *E. T. Davis, V. S. Underkoffler, R. N. Brey,* Leeds and Northrup Company (AIEE)

156. Ventilating Radiological Laboratories. *M. G. Kershaw,* E. I. du Pont de Nemours and Company (AIChE)

159. "Containment" Philosophy at the Savannah River Laboratory. *A. J. Hill, Jr.,* E. I. du Pont de Nemours and Company (AIChE)

Instrumentation for Reactors

Chairmen: T. S. Gray and J. D. Luntz

18. Hanford Reactor Instrumentation. *E. S. Day, Jr.,* General Electric Company (AIEE)

20. Reactor Instrumentation at Chalk River. *Albert Pearson,* Atomic Energy of Canada, Ltd. (AIEE)

21. Recent Developments in Instrumentation for Reactor Measurements at Argonne National Laboratory. *H. Bryant, R. Carlson, C. Curtis, S. G. Kaufman,* Argonne National Laboratory (ANS)

22. Problems of Production Reactor Instruments. *T. R. VickRoy,* E. I. du Pont de Nemours and Company (AIChE)

19. Dual-Function System for Gamma-Radiation Measurement. *M. B. Leboeuf, R. E. Connally, L. F. Miller,* General Electric Company (AIEE)

Reactor Control and Instrumentation

Chairmen: R. L. Witzke and James Landis

24. Instrumentation Requirements for a Research Reactor Facility. *Harold Lamonds and Reactor Staff,* North Carolina State College (ASME)

25. Reactor Controls and Instrumentation. *Samuel Untermyer,* General Electric Company (ASME)

26. Dynamics and Control of Nuclear Power Plants. *A. B. Van Rennes, J. C. Simons, Jr., T. S. Gray,* Massachusetts Institute of Technology (AIEE)

27. Hydraulic Nuclear Reactor Controls, *Michael Silverberg,* Engineer Research and Development Laboratories, Fort Belvoir, Va. (ASME)

28. Control of Heavy-Water-Modulated Massive Fuel Reactors. *E. Siddall,* Atomic Energy of Canada, Ltd. (AIEE)

353. Power and Temperature Control of Pressurized Water-Cooled Reactors. *W. H. Hamilton, J. N. Grace, O. R. Meyer, N. E. Wilson,* Westinghouse Atomic Power Division (AIEE)

Reactor Analysis Techniques

Chairmen: P. N. Ross and William Kerr

233. Analogue for Solution of Heat-Conduction Problems. *W. R. Simmons,* Argonne National Laboratory (AIChE)

234. Analysis of Temperature Transients in a Nuclear Power System. *Robert J. Fritz,* General Electric Company (ASME)

234a. A Nuclear Reactor Simulator for Teaching Purposes. *L. Orr, W. Kerr, H. J. Gomberg,* University of Michigan (AIEE)

234b. Use of Computers to Determine Time-Dependent Fission-Product Distribution. *J. V. Nehemias, R. C. Dennis, J. G. Lewis, H. A. Ohlgren,* University of Michigan (AIEE)

355. Problems of Mechanical Analysis in Reactor Technology. *G. Horvay,* General Electric Company (ASME)

Economics in Reactor Design

Chairmen: J. B. Mellecker and W. E. Barbour, Jr.

132. Economic Power Fueling Without U-235 Enrichment. *W. B. Lewis,* Atomic Energy of Canada, Ltd. (AIEE)

134. Special Technical and Economical Aspects of Small Nuclear Power Packages. *T. F. Nagey, W. W. Wachtl,* Glen Martin Company (AIChE)

135. Economics of Radiochemical Plants. *W. G. Stockdale,* Oak Ridge National Laboratory (ANS)

135a. Economics of a Fast Reactor Reprocessing Cycle. *P. W. Kupp*, Atomic Power Development Associates (AIChE)

Accelerators

Chairmen: J. G. Hutton and R. S. Shankland

166. Trends in the Design of Cyclotrons After 25 Years. *R. S. Livingston*, Oak Ridge National Laboratory (ACS)

167. Machine Sources of Ionizing Energy for Science, Medicine, and Industry. *J. G. Trump*, Massachusetts Institute of Technology (AIEE)

168. A 25-Billion-Electron-Volt Proton Synchrotron, *Martin Plotkin*, Brookhaven National Laboratory (AIEE)

169. Bevatron Magnet Pulse-Timing System. *W. C. Struven*, University of California Radiation Laboratory (AIEE)

171. Electron Linear Accelerator as a Pulsed Radiation Source. *M. G. Kelliher, J. C. Nygard, A. J. Gale*, High Voltage Engineering Corporation (IRE)

Annual Report Issued by Engineering Societies Library

In the Annual Report of the Director of the Library, it was stated that more persons visited the Library and were served by mail, telephone, and telegraph than last year. The number of words translated increased 63 per cent. Orders for bibliographies increased 33 per cent. More photoprints, microfilms, and searches were made for users of the Library, and members borrowed more books. Some Library use statistics follow:

	Amount	
Type	1953–54	1954–55
Visitors served	16,817	18,696
Nonvisitors served	21,278	21,740
Grand Total	38,095	40,436
Photoprint orders	4,704	4,598
Photoprints	63,506	65,728
Microfilm orders	295	330
Bibliography orders	586	781
Searches and paid services	127	142
Translations	161	204
Words translated	260,335	425,156
Borrowers	1,270	1,357
Books borrowed	1,640	1,753
Telephone inquiries	9,349	10,501
Written replies to inquiries	4,786	3,827

This year's increased use of the Library continues a trend that is more clearly shown by comparing the Library's income from paid services 5 years ago and now. The figures are comparable as service rates have not changed during the period. The income from paid services for the year 1949 to 1950 was $24,289; during the period 1954 to 1955 the income was $41,127. The 70 per cent increase in income in the last 5 years from the paid services of the Library is indicative of the generally increased use of the Library. Although exact measurement of the results of Library promotion has not been possible, there can be no doubt that part of the increased use of the Library is due to the greater promotion efforts sponsored by the Library Board in recent years.

In a contest sponsored by the publishers of *Iron Age* to locate the oldest available issue of the magazine, the Library's January 2, 1873 issue was the oldest one submitted. The Library Board voted to use the $500, first prize award, for promotion of the Library. The Library received considerable publicity as winner of the contest.

Coupon advertisements being published by *Civil Engineering* and *Electrical Engineering* are making the Library's services more widely known to members and others. The publication of these advertisements, without cost to the Library, is much appreciated. The American Institute of Mechanical Engineers continues to send the Library's folder to all new members.

Fine library service is dependent upon the excellence of the staff and the collection. Keeping the Library's collection outstanding, up-to-date, and readily usable requires continuous work by many members of the staff. The return of Mr. Rehn, head of the order department who had been on extended leave, made possible increased activity in acquiring little-known but important engineering books and reports from all parts of the world.

Periodicals and other serial publications have always formed an important part of the collection as they report new developments promptly and cover details and specific subjects not usually found in books. Increased time has been given to a study of periodicals being received through subscription, exchange, and gift. As the character or quality of some changed or deteriorated, subscriptions to them were discontinued. Many new periodicals have been examined and some of them have been added to the collection. The net gain in the number of periodicals received is 33 over a year ago.

Periodicals	1953–54	1954–55
Subscription	358	370
Exchange	280	291
Gift	755	765
Total	1,393	1,426

Other acquisitions for the Library's collection include volumes, maps, searches, and pamphlets. Countless items were received during the year, but many were of little value. The Library kept 3,453 items: 2,222 volumes, 1,168 maps, and 63 searches. In addition, 2,598 pamphlets were added to the Library, but as they were inserted in volumes already catalogued, they did not add to the total number of volumes. The accessions to the Library as of September 30, 1955, totaled 194,962, as follows: 171,973 volumes, 17,469 maps, and 5,520 searches. Many of the items kept were gifts. They were given to the Library by individuals, societies, companies, libraries, and schools. These gifts are much appreciated as it is difficult or impossible to obtain some of the material through the usual commercial channels. There were 1,036 volumes withdrawn from the Library.

The Library Staff prepared reviews of 605 books valued at $4,000, an 8 per cent increase over last year. These reviews were supplied to the four Founder Societies, the Engineering Institute of Canada, and the Engineering Index. In addition to the value of books received for review, the Library spent $2,145 for books that were not reviewed.

The tenth bibliography in the series of ESL Bibliographies was issued under the title "Bibliography on Unionization of Professional Engineers."

The Library Reading Room was painted. Not only is the appearance of the Reading Room much improved, but the effective light for readers is greatly increased. The walls were painted in 1949, but the entire room had not been painted since 1936.

New equipment has been acquired to save time and money, and to make the use of the Library more convenient. Co-operative work has been done for the good of the engineering profession and engineering libraries.

The Engineering Societies Monographs Committee, of which the Library Director is chairman, received three original manuscripts and a proposal for republication of the two Prandtl-Tietjens monographs published in 1934 and now out of print. All were still under consideration at the end of the year. Royalties received by the Library since the Engineering Societies Monographs series started in 1931 amount to $12,471.09.

Competition To Be Held by AIEE's Pittsfield Section

A written paper and oral competition will be held locally for younger members of the AIEE in February, it was announced by the Pittsfield Section of the AIEE. The competition will be one in addition to the yearly Tri-Sectional meet among the Schenectady, Lynn, and Pittsfield Sections scheduled for March.

Any person is eligible to compete who will be less than 31 years of age on March 31 and who has not previously presented a paper (except for a student paper) before a national or a district meeting of a recognized technical or professional society. Those who have spoken in previous tri-sectional competitions are ineligible, but those who have been alternates are eligible provided all other requirements are fulfilled.

In the local meet, the first prize will be $20, the second $15, and the third $10. Each of the six competing locally will also receive a suitable gift, such as a book or briefcase. In the Tri-Sectional competition, first prize is $75, second is $50, and third is $25. In both meets the prizes will be given on the basis of combined written and oral scores.

The purpose of the competition, according to the AIEE, is to give experience, recognize

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

excellence, and encourage activity within the organization in the writing and in the presenting of technical papers to technical audiences.

The papers are to present ideas of technical or scientific interest to an engineering audience. The oral presentation will cover the same subject as the written paper.

For additional information contact J. H. Spencer, General Chairman of the Competition, telephone number 8211, extension 591.

Fortescue Fellowship Applicants Must File by February 15, 1956

Funds have been made available for one or more Charles LeGeyt Fortescue Fellowships for 1956–57. The awards are made to postgraduate students in the field of electrical engineering who have received their baccalaureate degree from a duly recognized technical school in the United States or Canada. The amount of the award is to be determined by the committee in charge.

Candidates for the Charles LeGeyt Fortescue Fellowships should file applications on the form provided by AIEE so that they reach the chairman of the Fellowship Committee by February 15, 1956. Awards will be made not later than April 2. Copies of the application forms are available at accredited colleges or at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

The Charles LeGeyt Fortescue Fellowship, sponsored by AIEE, was established in 1939 as a memorial to Charles Fortescue in recognition of his valuable contribution to the electric power industry. The Westinghouse Electric Corporation, with which Dr. Fortescue was associated throughout his professional career, set up a trust fund of $25,000 to provide graduate fellowships to electrical engineers.

The successful candidates are selected by the AIEE committee which administers the fund.

It is intended that candidates shall pursue their studies at accredited engineering schools and engage in research problems meeting approval of the Fellowship Committee. To be eligible, the student must have received a bachelor's degree from an accredited college by the time his work under the fellowship would begin, provided he does not hold or subsequently receive any other fellowship which carries a stipend greater than the tuition required by the institution at which the graduate work is to be undertaken.

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

The John Fritz Medal Awarded in 1955 by ASME

The John Fritz Medal has been termed one of the highest honors that can be bestowed by the engineering profession. The basis for the award is "notable scientific or industrial achievement without restriction on account of nationality or sex." The fund is administered by the United Engineering Trustees, and four members of each of the Founder Societies constitute the Committee of Award: AIEE, American Society of Civil Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers.

Mr. Philip Sporn, president of the American Gas and Electric Company (AGE), New York, N. Y., has been presented the 1955 award at appropriate ceromonies in conjunction with the 75th Diamond Jubilee Annual Meeting of the American Society of Mechanical Engineers. The medal was awarded to him "as distinguished engineer, pioneer in utility engineering practices, eminent executive, human administrator."

The 1954 medal was awarded by the AIEE to H. A. Winne at the Winter General Meeting in New York, N. Y. The medal has included as its recipients such names as Alexander Graham Bell, Thomas Edison, General George Goethals, Orville Wright, Guglielmo Marconi, Herbert Hoover, and Vannevar Bush.

Mr. Sporn, as president of AGE, also is president of its subsidiary operating electric utility companies: Appalachian Electric Power Company, Indiana and Michigan Electric Company, Kentucky Power Company, Kingsport (Tenn.) Utilities, Inc., Ohio Power Company, and Wheeling Electric Company. He is president of the Ohio Valley Electric Corporation, a company formed in 1952 by 15 private electric utilities of the Ohio Valley region to supply the full electric power requirements of the Atomic Energy Commission's new atomic project near Portsmouth, Ohio. He was also elected president of the newly incorporated Nuclear Power Group, Inc., an organization of eight utility and engineering firms devoted to research and study of nuclear energy for electric power production; and vice-president of the American Nuclear Society, Inc., which he helped to found late in 1954. See the November issue of *Electrical Engineering*, "Personalities," for a complete listing of his AIEE activities.

Pittsburgh Section Holds Meeting

THE PITTSBURGH SECTION held its Organization Meeting combined with a smoker at the University Club, so that more of the members could become familiar with the technical and social program for the year, as well as meet officers and committee members. An important group with Section officers, District Vice-President, and two past chairmen. Left to right, R. N. Wagner, L. J. Berberich, B. M. Jones, A. A. Johnson, C. T. Pearce, and W. H. Osterle.

Engineering Foundation Grants Advance Varied Research Projects

The Engineering Foundation, which administers the income from a $1.5 million fund dedicated to the stimulation of engineering research, now has made available its allocations for the 1955–1956 fiscal year. Although the income of about $50,000 seems modest in comparison with the present-day scale of research expenditures, it has served to nurture in early stages many research programs which have ultimately attracted large-scale financial support from other sources and become projects of major import.

The 1955 grants totaled $61,850. The grants will advance 26 projects, which are receiving an estimated outside support of $426,000. The projects, which cover a wide range of research, are being carried out in university laboratories under nation-wide sponsorship of the major engineering societies.

An important project receiving one of the grants is a study of the properties of steam, which is being sponsored by the American Society of Mechanical Engineers (ASME). The Steam Properties Research Program, which was established at the Fourth International Steam Tables Conference in Philadelphia on September 1954, revives an earlier ASME program that was completed in 1934. The extremely high pressures and temperatures commonly used today in both steam-power generation and chemical processing emphasize the need for extending the present working steam tables that have been in use since 1934. A first step in the research program involves obtaining experimental data for extending steam table ranges to 1,500 F and 15,000 psia.

The decline in the cost of electric power in the past decade of steadily rising prices to a large extent may be attributed to studies by turbine and steam generator manufacturers and power generating companies, which have made it possible for central station generating plants to improve their efficiency by the use of increasingly higher steam temperatures and pressures. Receiving the support of these groups as well as of the Engineering Foundation is an ASME supported program on high-temperature steam generation which began in 1932; it was discontinued during the war, but re-established since 1949. This ASME project is attempting to lower electric power costs still further by studying the possibility of using a regenerative steam cycle at temperatures up to 1,650 F. Of particular concern to this group is the severe corrosive action of high-temperature steam and the lack of metallurgical stability of the materials available for superheater tubing. New tests will be made at the Philip Sporn plant of the American Gas and Electric Company, where steam is available at 1,000 F temperature and 2,000-psi pressure. For these tests special apparatus has been designed in co-operation with the United States Navy Bureau of Ships.

A 3-year research project on the thermal resistivity of soils—cosponsored by the AIEE Engineering Foundation, and various other groups—is beginning at Princeton University, Princeton, N. J. This project was authorized to study the heat-dissipation characteristics of various soil types. Such information is useful in the determination of the load-carrying capacity of underground cable systems and in many other fields of engineering. The project will cover such factors as effect of soil solids content, critical heat rate, critical temperature gradients, moisture migration effects, and rewetting characteristics of clays.

Grants are also being made to eight projects under sponsorship of the American Institute of Mining and Metallurgical Engineers (AIME). The AIME projects include a newly instituted program for predicting disastrous storm surges, which is starting at Columbia University's Lamont Laboratories at Palisades, N.Y.

Mexico Section Honors Vice-President

The Mexico Section of AIEE dedicated a recent dinner meeting to "Welcome to Mexico Night" for visiting Vice-President S. M. Sharp, AIEE District 7, and wife. The session was attended by executives and heads of major private and government electric utilities in Mexico, and members and wives.

AIEE Nominating Committee to Meet at the Winter Meeting

The AIEE Nominating Committee is now complete and prepared to receive suggestions or proposals from the membership directly or through the Secretary in accordance with Article VI, Sections 30–33 of the Constitution, and Sections 27 and 28 of the Bylaws. Other pertinent information may be found in the article, "Election Procedure for Institute Officers," by L. F. Hickernell, chairman, Planning and Co-ordination Committee, published in *Electrical Engineering*, April 1955, pp. 278–80. The Nominating Committee will meet in the Hotel Statler, New York City, N. Y., 10 a.m., January 30, 1956, during the Winter General Meeting of the Institute to nominate candidates for AIEE officers to be voted on by the membership in the Spring of 1956. Members of the committee are:

Representatives for the eleven geographical Districts:

1. E. K. Rohr, General Electric Company, 920 Western Avenue, Lynn, Mass.
2. A. C. Muir, Berwind-White Coal Mining Company, 1400 Pennsylvania Building, Philadelphia 2, Pa.
3. R. T. Weil, Jr., Manhattan College, New York 63, N. Y.
4. W. F. Criley, Department of Electrical Engineering, Vanderbilt University, Nashville, Tenn.
5. J. R. North, Commonwealth Services, Inc., 252 West Cortland Street, Jackson, Mich.
6. A. S. Anderson, General Electric Company, P. O. Box 2331, Denver 1, Colo.
7. C. C. Homan, Jr., El Paso Natural Gas Company, El Paso, Tex.
8. W. G. Collins, Pacific Tel. and Tel. Company, 140 New Montgomery Street, San Francisco, Calif.
9. J. A. McDonald, General Electric Company, 200 S. Main Street, Salt Lake City, Utah
10. D. M. Farnham, Quebec Hydro-Electric Commission, P. O. Box 6106, Montreal, Que., Canada
11. G. R. Canning, Ohio Bell Telephone Company, 750 Huron Road, Cleveland, Ohio

Alternates for District representatives:

1. R. Cutts, Jr., General Electric Company, 1 River Road, Schenectady 5, N. Y.
2. H. H. Sheppard, Rumsey Electric Company, 1007 Arch Street, Philadelphia 7, Pa.
3. W. A. Clark, American Telephone and Telegraph Company, 195 Broadway, New York, N. Y.
4. Thomas Salisbury, Gregory-Salisbury and Company, Jackson, Miss.
5. W. L. Cassell, Department of Electric Engineering, Iowa State College, Ames, Iowa
6. W. C. DuVall, Electrical Engineering Department, University of Colorado, Boulder
7. H. J. Kongabel, 2309 University Boulevard, Houston, Tex.
8. Whitman Ridgway, General Electric Company, 235 Montgomery Street, San Francisco, Calif.
9. J. A. Davis, 1455 Crandall Avenue, Salt Lake City, Utah
10. W. R. Way, The Shawinigan Water and Power Company, P. O. Box 6072, Montreal, Que., Canada
11. W. R. Hough, Reliance Electrical and Engineering Company, 1088 Ivanhoe Road, Cleveland 10, Ohio

Representatives for the five technical Divisions:

Communication—I. S. Coggeshall, Western Union Telegraph Company, 60 Hudson St., New York 13, N. Y.

General Applications—R. L. Oetting, General Electric Company, Nela Park, Cleveland 12, Ohio

Industry—G. W. Heumann, General Electric Company, 1 River Road, Schenectady 5, N. Y.

Power—C. T. Hatcher, Consolidated Edison Company of New York, Inc., 4 Irving Place, New York 3, N. Y.

Science and Electronics—S. Reid Warren, Jr., University of Pennsylvania, 220 South 33rd Street, Philadelphia, Pa.

Alternates for Division representatives:

Communication—John Meszar, Bell Telephone Laboratories, Inc., 463 West Street, New York 14, N. Y.

General Applications—T. C. Johnson, General Electric Company, 5 Lawrence St., Bloomfield, N. J.

Industry—C. N. Clark, Duquesne Light Company, 435 Sixth Avenue, Pittsburgh, Pa.

Power—E. I. Pollard, Elliott Company, Ridgway, Pa.

Science and Electronics—J. G. Reid, Jr., ACF Electronics, 800 North Pitt Street, Alexandria, Va.

Representatives for the Board of Directors:

J. H. Foote, Commonwealth Services, Inc., 252 West Cortland Street, Jackson, Mich.

E. R. Jones, Mountain States Tel. and Tel. Company, Box 960, Denver 1, Colo.

R. E. Kistler, Pacific Tel. and Tel. Company, 1200-3rd. Avenue, Seattle, Wash.

T. M. Linville, General Electric Company, Research Services Division, P. O. Box 1088, Schenectady, N. Y.

J. C. Woods, Commonwealth Edison Company, 72 West Adams Street, Chicago 90, Ill.

Alternates for Board representatives:

G. T. Pearce, Westinghouse Electric Corporation, 3001 Walnut Street, Philadelphia 4, Pa.

G. S. Purnell, Westinghouse Electric Corporation, 600 St. Paul Avenue, Los Angeles 17, Calif.

S. M. Sharp, Southwestern Gas and Electric Company, Shreveport, La.

Alfred Noble Prize Awarded to R. L. Bright

R. L. Bright, advisory engineer in the semiconductor department, Westinghouse Electric Corp., Pittsburgh, Pa., has been awarded the Alfred Noble Prize for 1955 for his paper "Junction Transistor Used as Switches." The prize will be presented to him at the AIEE Winter General Meeting in New York, N. Y.

The Alfred Noble Prize, instituted in 1929, is a cash award with a suitably engraved certificate from the income of a fund contributed by engineers and others in honor of Alfred Noble. The prize for 1955 is $400.

R. L. Bright was born in Oil City, Pa., 1925. He received a bachelor of science degree in mathematics and a doctors degree in electrical engineering from Carnegie Institute. In 1945 he was engaged in the design of relay control systems for remote control aircraft with the Air Force Radio Laboratories, Wright Field, Dayton, Ohio. In 1946, he became an instructor of electrical engineering at Carnegie Institute. In 1953 he joined Westinghouse as an engineer. He is a member of the Institute of Radio Engineers, Tau Beta Pi, Eta Kappa Nu, Sigma Xi and Pi Mu Epsilon. He has served on the AIEE Committee on the newly established Solid-State Devices (1955–56).

Panel Discussion Group Feature of Textile Conference

The Textile Conference, held in Raleigh, N. C., at the North Carolina State College on November 3–4, 1955, was the most successful that the Textile Subcommittee has held. The attendance was 238 and the meeting hall was filled.

The conference was unique in that it featured a panel discussion which covered all types of electrical problems and their remedies. The operation of this panel was such that not only were the participants eager and willing to take part in the discussions of their problems, but it was actually necessary to conclude this portion of the program even before all of the questions could be answered completely. It was felt that this discussion, which lasted approximately 3 hours, should be concluded and, therefore, it was interrupted for lack of time and not lack of audience interest.

Another feature of this particular conference which tends to make it attractive is the fact that the Conference Committee, operating under the leadership of one of the Textile Subcommittee members as chairman, spends much time in preparing for the conference.

Victor Sepavich of Crompton and Knowles Loom Works, Worcester, Mass., is chairman of the Textile Industry Subcommittee which sponsored the conference. Dan McConnell of Cone Mills Corporation, Greensboro, N.C., was the leader of the panel discussion group, and J. T. Meador of Southern Service Company, Charlotte, N. C., was general chairman of the conference.

Lehigh Valley Section Bucknell University Meeting

Members of the AIEE Lehigh Valley Section met at Bucknell University, Lewisburg, Pa., November 11, 1955. C. T. Pearce, vice-president of District No. 2, also attended. After bringing up-to-date news from national headquarters, Mr. Pearce, Westinghouse Electric Company, presented a talk entitled, "An Electrical Engineering Career in a Manufacturing Organization," which was directed mainly to the Student members present.

The principal speaker of the evening was A. N. Haig, application engineer for the transformer department of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., who explained how the betatron was used to X-ray metal castings and forgings for possible flaws and imperfections. Mr. Haig's subject was the application of the "24-Million-Volt Betatron." The treatment of cancer by use of the betatron and the advantages of this type of treatment were also discussed by Mr. Haig.

Concluding the meeting, Mr. Pearce, presented D. L. Greene, the Section chairman for 1954–55, with the past chairman's certificate and pin. Mr. Greene then presented certificates and prizes to the winners of the prize in the Section paper competition for last year.

C. T. PEARCE, vice-president (left), presents past chairman's certificate and pin to D. L. Greene, Lehigh Valley Section 1954–55.

COMMITTEE ACTIVITIES

Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Communication Division

Committee on Telegraph Systems (R. B. Shanck, *Chairman;* C. H. Cramer, *Vice-Chairman;* V. N. Vaughan, Jr., *Secretary*). "The organization meeting on a new Printing Telegraph Subcommittee, W. Y. Lang, chairman, was held in Chicago, Ill., on October 5 for work on a task which is considered of great importance to the telegraph industry. The purpose of the Subcommittee is to establish test procedures and limits of the amount of distortion of signals sent from various transmitting devices, and to establish limits of the receiving margins for the receiving devices. The types of circuits used in the testing apparatus and the types of test equipment required will be outlined in the test procedure.

Inasmuch as transmitting speeds for printing telegraph signals are increasing from the present 60, 75, and 100 words per minute to 200 and above, the task which has been outlined for the Subcommittee assumes major proportions if the result is to be useful to suppliers for reference and design purposes, as well as to the operating administrations."

General Applications Division

Committee on Land Transportation (M. C. Swanson, *Chairman;* E. A. Foster, *Vice-Chairman;* P. G. Lessman, *Secretary*). In general, Subcommittee work is directed toward enlightening the public on new developments in the use of electric apparatus in transportation. Work is being done on practices in maintenance of insulation, symbols of wiring diagrams, train resistance at high speed, rules for rotating apparatus used on land transportation vehicles within AIEE, American Standards Association (ASA), and International Electrotechnical Commission (IEC). In the latter category, ASA-35 and AIEE No. 11 rules have been drafted and are ready for printing.

Industry Division

Committee on Industrial Power Systems (R. H. Whaley, *Chairman;* R. T. Woodruff, *Vice-Chairman;* H. H. Angel, *Secretary*).

The Industrial Power Systems Committee is continuing in its effort to publish material as recommended guides to engineers. These publications, which will be identified as the Red, Green, and Grey Books, pertain to "Electric Power Distribution for Industrial Plants," "Grounding in Industrial Plants," and "Electric Systems for Commercial Buildings," respectively.

The Green Book, which is the work of the Industrial Grounding Subcommittee, is being published by the Standards Committee as a recommended guide.

The Red Book, which is the work of the Electric Power Distribution for Industrial Plants Subcommittee, has been approved by the Industrial Power Systems Committee and the final form will be submitted to the Standards Committee for approval and publication as a recommended guide. A standing committee has been established for the Red Book to keep the book up-to-date continually in accordance with changes and developments that occur in industry.

The Grey Book, which is the work of the Distribution Systems for Commercial Buildings Subcommittee, is being written by 66 members of the AIEE who are specialists in various phases of the work that will be incorporated in the text of the publication "Electric Systems for Commercial Buildings."

The Industrial Power Systems' Committee is developing a committee activity in order to establish standard nomenclature for the various types of distribution systems. The purpose of such a report is to serve as a standard guide for engineers in describing the various types of electric systems that can be installed.

The Pacific Coast Subcommittee is developing sessions for the Summer General Meeting in San Francisco, Calif., in 1956, and technical sessions are being developed and planned for all the general meetings between now and the summer of 1957.

Science and Electronics Division

Metallic Rectifier Committee (D. E. Trucksess, *Chairman;* E. A. Harty, *Vice-Chairman;* L. W. Burton, *Secretary*). In July 1955 the International Electrotechnical Commission held a meeting to discuss and formulate plans for international standards on metallic rectifiers. E. A. Harty, former secretary and now vice-chairman of the AIEE committee, was delegated to represent both the AIEE and National Electrical Manufacturers Association (NEMA) committees. The deliberations took place from July 4, 1955, to July 9, 1955, and 10 countries were represented. Over 24 engineers, prominent in this industry, represented their countries and 1,000 man-hours were spent at this meeting.

The international name for the Committee will be: Semiconductor Rectifier Subcommittee 22-2, and will report to Technical Committee No. 22 on Power Converting Equipment.

In preparing the first draft, both the AIEE and NEMA Standards were used by the secretariat as references. The first standards will cover rectifier stacks and units only, and no attempt will be made as yet to cover specialized applications of these rectifiers. Copies of these standards will be available for study early in February 1956 by each country, and a formal meeting is planned for July 1956 in Munich, Germany, to discuss and obtain international agreements.

Power Division

Committee on Protective Devices (E. G. Norell, *Chairman;* E. M. Hunter, *Vice-Chairman;* K. H. Kidd, *Secretary*). The final report on Standards for Valve and Expulsion Type Lightning Arresters, dated September 1, 1955, has been submitted to the Standards Committee for approval. This report was prepared in order to revise and combine American Standards Association (ASA) Standard C-62.1, which included only valve arresters, with the reports on AIEE Proposed Standards Nos. 24, 28A, and 47. This standard was issued as a report rather than as an AIEE standard, since the ASA Sectional Committee C-62 is now working actively on the revision of the existing ASA standard, and it is expected that the information contained in this report, if approved, will be incorporated in the ASA standard.

A working group has been organized to revise AIEE Standard No. C-32 on Neutral Grounding Devices. The existing standard, which was issued in 1947, will be revised and arranged so that ultimately it can be an ASA standard. It is expected that the Grounding Application Guides, which were recently published as Committee Report AIEE No. 954, will be included as an appendix to this standard.

The working group on Protection of Multi-Circuit Substations is studying actively the influence of multiple lines on the wave shape and magnitude of incoming surges. The working group intends to evaluate the effect of the additional lines and obtain information which will assist in the application of lightning arresters. A preliminary report is planned for January 1957.

Other projects under study by the Protective Devices Committee are: Surge Protection of Aerial Cable, Surge Protection of Rotating Machines, and Lightning Arrester Application Guide.

AIEE FELLOWS ELECTED

Fulton Cutting (M '17), professor of physics and assistant to president, Stevens Institute of Technology, Hoboken, N. J., has been transferred to the grade of Fellow in the AIEE ". . . for services to electronic engineering in the fields of research, management, and education." Dr. Cutting was born in New York, N. Y., on December 27, 1886. He attended Harvard University where he obtained a bachelor of arts degree in 1909; he received a master of arts degree in physics in 1910, a mechanical engineering degree in 1911, and a doctor of engineering degree in 1915. Dr. Cutting has gained recognition for his contributions to the radio communications art. He has a wide background of engineering teaching and executive experience which began in 1914. During World War I, he gained experience with radio transmitters for aircraft, patrol boats, and submarines. He was a member of the Bureau of Aircraft Production. During the early twenties he was engaged in the development and manufacturing of commercial radio apparatus with Cutting and Washington, Inc. He also sold ship-to-shore equipment. Then he joined the Colonial Radio Corporation and became president and, subsequently, chairman of the board. This enterprise was consolidated in 1930 with the Valley Appliance Company, a Symington concern. It was at this time that he became chairman of the board, but he had the unofficial position of consulting engineer. The concern was rather unusual in that it had only three customers—Sears Roebuck and Company, General Motors Corporation, and the Chrysler Corporation. There was no credit department. Technical achievements included the first adequate bedside radio to sell for ten dollars, and the first radio-phonograph console with an automatic record changer to sell under $100. During World War II, the Colonial Radio Corporation was engaged mainly in the manufacture of command sets, *SCR 522*, and Dr. Cutting was active in this work. By means of extensive subcontracting, the company's yearly volume was increased tremendously. He was also a member of the Operational Research Staff, U. S. Signal Corps, where he was concerned chiefly with radar, radar counter measures, and counter radar counter measures. At the end of the war, the Colonial Radio Corporation was sold to Sylvania Electric Products, Inc., and he joined the staff of Stevens Institute of Technology. Since 1947, he has been co-ordinating research activities at Stevens and is in charge of an electronics course. He is the acting head of the physics department, assistant to the president, and a member of the Board of Trustees. Dr. Cutting is a past president and Fellow of the Institute of Radio Engineers. He is at present a Life Member. He is also a member of the Acoustical Society, and the American Physical Society.

F. Cutting

AIEE PERSONALITIES

L. A. Umansky (M '27, F '45, Member for Life), engineering manager, Industrial Engineering Division, General Electric Company, Schenectady, N. Y., has been awarded the Edison Medal for 1955 ". . .for his outstanding contribution to the electrification of industry through the application of electric machines, devices and systems to automatic process machinery; and for his inspiration, leadership, and teaching of men in this work." The Edison Medal will be presented to Mr. Umansky during a special session of the AIEE Winter General Meeting, January 31, 1956, in New York, N. Y. Mr. Umansky was born in Nicolaiev, Russia, in 1890. He studied electrical engineering at the St. Petersburg Polytechnic Institute and graduated in 1915, during the World War I. In the same year, he was sent to the United States as munitions inspector for the Russian Artillery Commission. He joined the General Electric Company in 1919 as a test engineer, after the war. In 1920, he was transferred to the power and mining engineering department, later known as the industrial engineering department, as an applications engineer. He specialized primarily in power applications in the steel industry, and in 1936 was placed in charge of engineering activities in the firm. He was made assistant manager of engineering of this department in 1950, a position he held until his retirement in 1955. As manager of engineering, he supervised the company's application engineering work in all industries. Mr. Umansky is a member of the Association of Iron and Steel Engineers. He was chairman of the AIEE Schenectady Section (1944–45). He has served on the following AIEE committees: General Industry Applications and its predecessor (1941–54, Chairman 1947–54); Lamme Medal Awards (1948–51); Prize Awards for Papers (1950–53); Application to Iron and Steel Production (1936–38); Industrial Power Applications and Systems (1938–47); Industry Co-ordinating (1947–49); Standards (1947–49); and Technical Program (1947–49).

L. A. Umansky

J. W. Barker (M '26, F '30), chairman and president of the Research Corporation, New York City, N. Y., has been nominated to serve as next president of The American Society of Mechanical Engineers. Mr. Barker, a native of Lawrence, Mass., was graduated in 1916 from the Massachusetts Institute of Technology, to which he returned as an associate professor in 1925. He became head of the electrical engineering department at Lehigh University in 1929, and dean of engineering at Columbia University in 1930, a post he held until 1946. During World War II he served as special assistant to the Secretary of the Navy, being responsible for all naval education and training policy, including the V-12 college training program. Mr. Barker will continue in his post as head of Research Corporation. He is chairman of the board of the wholly owned subsidiary, Research-Cottrell, Inc., and current president of Sigma Xi, national scientific association. He is a director of National Malleable and Steel Castings Company, and has been a member of the advisory committee of the U.S. Coast Guard Academy since 1934, and chairman of that committee since 1952. He has served as AIEE vice-president of District 3 (1940–42). He has also served on the following committees: Production and Application of Light (1929–42, Chairman 1933–35); Education (1930–40, Chairman 1937–39); Technical Program (1932–42, Chairman 1939–41); Publication (1934–42); Award of Institute Prizes (1937–42, 1945–47, Chairman 1939–41); Edison Medal (1938–43); Planning and Co-ordination (1939–41); Research (1945–51, Chairman 1945–47); Charles LeGeyt Fortescue Fellowship (1945–51); Engineering Foundation Board (1947–56); Iwadare Foundation (1936–42); U. S. National Commission on Industrial Illumination (1939–47); and the Council of the American Association for the Advancement of Science (1940, 1945–56).

Lee de Forest (AM '04, F '18, Member for Life, *Edison Medalist*), director, American Television, Inc., and United Engineering Company, Los Angeles, Calif., has been awarded the Audio Engineering Society's John H. Potts Award for outstanding achievement in audio engineering. The Society honored outstanding figures in its field at its Annual Banquet, held in conjunction with its Seventh Annual Convention at the Hotel New Yorker, New York. The Society bestowed three awards for achievement, two honorary memberships, and eight fellowships. Dr. de Forest was honored for his invention of the thermionic amplifier tube; detector, amplifier and oscillator circuits, and improvements in sound motion pictures. Often called the "Father of Radio," Dr. de Forest has received over 300 patents, in such fields as circuits, wire telephony, and television. He received the AIEE Edison Medal in 1947. **W. L. Everitt** (AM '25, F '36), dean of engineering at the University of Illinois, Urbana, received an honorary membership for his work in electronics, including research and supervision of wartime developments as director of the Operational Research Staff of the Office of the Chief Signal Officer, and for writing and editing technical books. Mr. Everitt has served as AIEE Director (1947–51) and has been on the following Committees: Communication (1932–42, Chairman 1937–39); Technical Program (1937–39); Education (1944–50); Edison Medal (1947–51); Research (1947–51); Board of Directors (1947–51); Executive (1949–51); Volta Scholarship Trustee (1949–51); Commission of Washington Award (1951–53); Television and Aural Broadcasting Systems (1953–56); and Electronics (1955–56). **G. L. Walsh** (AM '28, M '52), engineer, Walsh Engineering Company, Elizabeth, N. J., was one of the recipients of the Fellowship awards for pioneer work on low-power, low-distortion power amplifiers and transformers.

W. F. Davidson (AM '14, F '26, Member for Life), research engineer of the Consolidated Edison Company of New York, N. Y., retired after 33 years service with the New York utility system. Mr. Davidson joined the Brooklyn Edison Company in 1922 as director of research from the University of Michigan, where he was assistant professor of electrical engineering and where he had earned electrical and mechanical engineering degrees. During the 1920's with Brooklyn Edison, he led a research group which did pioneering work in 27,000 v underground electric distribution system design, and was engaged in special studies of power plant equipment and construction materials. Later, in the 1930's his research studies in boiler and furnace combustion conditions contributed to Con Edison's development of high-pressure, high-temperature boilers. He also pioneered in the study of air pollution and made the first and only scientific analysis of soot fall-out in New York City. Following the merger of Brooklyn Edison with Consolidated Edison in 1936, Mr. Davidson was named director of research. During World War II, he was a consultant to the chairman and was deputy executive officer of the National Defense Research Committee. He was awarded a Presidential Certificate of Merit for his work with this group which was engaged in vital wartime research that led to technological advances. He also served as a consultant to the Smaller War Plants Corporation during the war years. In recent years, Mr. Davidson has been active in research and engineering planning leading to Con Edison's entry into the nuclear power field, marked early this year by the company's application to the Atomic Energy Com-

W. F. Davidson

mission for a license to build a 250,000-kw atomic power station. Among many diverse activities in engineering fields he had been secretary and chairman of the Conference on Electrical Insulation of the National Research Council (NRC); member-at-large and executive committee member of the Division of Engineering and Industrial Research of the NRC; chairman of the Committee on Electric Power Cables, American Standards Association; member of the U. S. delegation to the International Electrochemical Commission; and chairman of the Engineering Subcommittee of the U. S. National Committee to the Conference International des Grand Reseaux Electriques à Haut Tension. He is a Fellow of the American Society of Mechanical Engineers; an Associate Fellow of the Institute of Aeronautical Sciences; senior member of the Institute of Radio Engineers; and member of the Institution of Mechanical Engineers, London, England; and of the American Meteorological Society. He has served on the following AIEE Committees: Research (1925–41, Chairman 1939–41); Basic Sciences (1927–42, Chairman 1934–36); Technical Program (1934–36, 1939–40); Award of Institute Prizes (1939–41); Charles LeGeyt Fortescue Fellowship (1939–44); Nucleonics (1947–50, Chairman 1950–53); Science and Electronics Co-ordinating Division (1949–52); and Engineering Societies Monographs (1950–56).

R. S. Barbaras (AM '49), sales engineer, Stupakoff Division, Carborundum Company, has been appointed manager, distribution equipment sales, R&IE Equipment Division, I-T-E Circuit Breaker Company, Greensburg, Pa. Mr. Barbaras was previously sales manager with the S&C Electric Company, where he gained experience in market study and field sales of power fuses and load break switches. Prior to this he handled distribution sales in the Electronics Divisions of Western Electric Company and National Vulcanized Fibre Co. for many years. He was a major in the Signal Corps from 1941 to 1945 in the China-Burma war theater. He received a bachelor of science degree from Norwich University, Northfield, Vt. **H. W. Graybill** (M '47), sales application engineer, I-T-E Circuit Breaker Company, was appointed manager, industrial product sales, R&IE Equipment Division. General utility sales will be directed by **H. A. Glover** (AM '39), the sales manager.

OBITUARIES

Alva Benson Clark (M '19, F '30), former vice-president of Bell Telephone Laboratories, died November 14, 1955 after a short illness. Mr. Clark was born in Clay Sentre, Ohio, 1890. His telephone career began in 1911 when he joined the American Telephone and Telegraph Company (A.T.&T.) immediately after receiving a bachelor of science degree in electrical engineering from the University of Michigan. He was a member of A.T.&T.'s engineering department from 1911 to 1919 and its department of development and research from 1919 to 1934, at which time that department was consolidated with Bell Laboratories. After serving as toll transmission development engineer at A.T.&T., Mr. Clark was named toll transmission development director of Bell Laboratories in 1934 and director of transmission development in 1935. In 1940 he became director of systems development, assuming general direction of Bell Laboratories' work in telephone switching, transmission, and equipment development. When he became vice-president of the Bell System in 1944, his previous responsibilities were extended to include outside plant development. In 1947, he was placed in charge of switching research and in 1949 assumed direction of the development of apparatus for incorporation in switching and transmission systems. From June 1951 until his retirement, Mr. Clark was in charge of coordinating all Bell System programs at Bell Laboratories, and was responsible for the Laboratories' relations with A.T.&T. and the Western Electric Company in all programs for the Bell System. From 1938 to 1955 Mr. Clark was Bell System chairman of the joint Subcommittee on Development and Research of the Edison Electric Institute and the Bell System. He had served as Director of Research and Development in a sector of the Department of Defense in Washington, D. C. He retired from the Bell Laboratories last February after more than 43 years of service with the Bell system. His career was marked by notable contributions to the expansion of long distance telephone facilities. He led the planning and engineering of the transcontinental coaxial cable and the microwave radio relay systems for telephone and television transmission, as well as the earlier systems employing the "carrier" technique by which many messages can be carried simultaneously over one electric pathway. More recently, he directed the development and engineering of the nationwide direct distance dialing system, already in operation in a number of localities, by which telephone customers eventually will be able to dial any telephone in the country without assistance of an operator. He also guided the development of the automatic message accounting system, now extensively used throughout the Bell System. He was a Fellow of the Acoustical Society of America, and a member of Tau Beta Pi, Sigma Xi, and the American Association for the Advancement of Science. He was named recently to become a Fellow of the Institute of Radio Engineers. In 1941 his alma mater, the University of Michigan, cited him as a Distinguished Alumnus.

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting November 17, 1955, recommended the following members for transfer to the grade of membership indicated. Any objections to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Balsam, L. L., general supervisor, Airborne Guidance Development, Northrop Aircraft, Inc., Hawthorne, Calif.
Baumgartner, R. P., laboratory supervisor, Westinghouse Electric Corp., East Pittsburgh, Pa.
Bleshman, N. A., electrical engineer, Ebasco Services, Inc., New York, N. Y.
Bender, F. M., division chief, Weston Electrical Instrument Corp., Newark, N. J.
Carlstad, A., electrical engineer, Coos-Curry Electric Corp., Inc., Coquille, Ore.
Cook, P. E., chief engineer, Pittsburgh Works, Allis-Chalmers Manufacturing Co., Pittsburgh, Pa.
Cornell, F. J., production & development engineer, Tocco Div., Ohio Crankshaft Co., Cleveland, Ohio
Crooks, J. W., Jr., engineering design specialist, Consolidated Vultee Aircraft Corp., San Diego, Calif.
Crossett, G. L., supt. of maintenance, A. O. Smith Corp., Milwaukee, Wis.
Davidson, F. A., chief of operations branch, Wright-Patterson AFB, Ohio
DeHaas, J. C., relay application supervisor, Arizona Public Service Co., Phoenix, Ariz.
Fegley, K. A., asst. professor, elec. engg. dept., University of Pennsylvania, Philadelphia, Pa.
Fitch, R. N., senior engineer, American Gas & Electric Service Co., New York, N. Y.
Foote, H. L., asst. to vice pres.-engineering, Stromberg-Carlson Co., Div. of General Dynamics Corp., Rochester, N. Y.
Freitas, E. A., design specialist, Northrop Aircraft, Inc., Hawthorne, Calif.
Freund, R. J., consulting engineer, Premier Electrical Construction Co., Chicago, Ill.
Gunn, P. L., chief system operator, Southwestern Gas & Electric Co., Shreveport, La.
Haley, C. C., design engineer, Westinghouse Electric Corp., Sharon, Pa.
Hofner, C. W., load dispatcher, Interchange Power Services, Inc., Des Moines, Iowa
Johnson, F. L., division engineer, Southwestern Gas & Electric Co., Texarkana, Ark.
Jones, A. P., electrical engineer, Central Power & Light Co., Corpus Christi, Tex.
Kerchner, W. J., Jr., electrical engineer, Gilbert Associates, Inc., Reading, Pa.
Kerr, J. M., asst. electrical engineer, Pennsylvania Electric Co., Johnstown, Pa.
Kochenburger, R. J., professor of electrical engineering, University of Connecticut, Storrs, Conn.
Leightty, J. H., development engineer, Electric Controller & Manufacturing Co., Cleveland, Ohio
Lingo, L. E., asst. professor, electrical engineering dept., University of Massachusetts, Amherst, Mass.
Macpherson, R. H., engineering unit supervisor, General Electric Co., Philadelphia, Pa.
Martin, B. H., head, Commercial and Industrial Power Section, Tennessee Valley Authority, Chattanooga, Tenn.
Mykita, J., senior design draftsman, chemical plants div., Blaw-Knox Co., Pittsburgh, Pa.
Peterson, R. A., electrical engineer, U. S. Bureau of Reclamation, Phoenix, Ariz.
Rae, O. O., vice-president, Westinghouse Electric Corp., Atlanta, Ga.
Rubenstein, C. F., associate scientist, Leeds & Northrup Co., Philadelphia, Pa.
Schwab, R. L., design engineer, Westinghouse Electric Corp., Sharon, Pa.
Seat, A. W., transmission engineer, Puget Sound Power & Light Co., Seattle, Wash.
Stevens, V. D., supervisor, Phoenix div. engineering, Arizona Public Service Co., Phoenix, Ariz.
Taliaferro, H. B., director of power utilization, Power Authority, State of New York, N. Y.
Williams, D. R., supervisor, ordnance engineer, Naval Ordnance Laboratories, White Oak, Md.
Wong, S. Y., project engineer, Philco Corp., Philadelphia, Pa.
Zverev, A. I., senior engineer, Westinghouse Electric Corp., Baltimore, Md.

39 to Grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member, have been received from the following candidates, and any member objecting to election should so notify the Secretary before January 25, 1956, or February 25, 1956, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Barrett-Smith, T. I., Jr., Bell Telephone Labs., New York, N. Y.
Buchhold, T. A., General Electric Co., Schenectady, N. Y.
Clark, R. M., Dingle Clark Co., Cleveland, Ohio
Duffy, E. H., Sperry Gyroscope Co., Baltimore, Md.
Fifer, S., Dian Laboratories, Inc., New York, N. Y.
Freeman, W. H., Motorola, Inc., Chicago, Ill.
Gruener, G. G., Landauer & Shafer, Lemmon, Dallas, Tex.
Isom, L. M., Public Service Co. of Indiana Inc., Plainfield, Ind.
Kalipolis, A., Mutual Boiler & Machinery Insurance Co., Waltham, Mass.
Knowles, J. O., Brookhirst Switchgear Ltd., Chester, England
Lewis, H. A., Florida Power & Light Co., Miami, Fla.
Longley, J. F., West Texas Utilities Co., Abilene, Tex.
Magnuski, H., Motorola, Inc., Chicago, Ill.
McLaughlin, J. F., Iowa Power & Light Co., Des Moines, Iowa
Morrill, W., General Electric Co., Pittsfield, Mass.
Pennington, J. F., Georgia Power Co., Atlanta, Ga.
Smith, R. J., Mersey Cable Works Ltd., Bootle, Liverpool, England

17 to grade of Member

OF CURRENT INTEREST

MOUNTED OUTSIDE on head end of New Haven Railroad multiple-unit car equipped for remote control operation (right) are two receiving coils which pick up inductive carrier signal, one to receive signal from wayside telephone on platform of Larchmont Station (left) and the other for car control signal from equipment mounted in a station wagon. Handset is for talking to car and reply is received via speaker at top with switches to relay moves to control panel.

Radio Remote Control Runs Experimental Train on New Haven Railroad

FOR MANY YEARS men have dreamed of running a railroad locomotive by remote control. This was accomplished recently on the New Haven Railroad in the New Rochelle–Rye, N. Y., territory. The train was one of the New Haven Railroad's new multiple-unit cars. It could have been a diesel or electric locomotive with a full complement of cars. The control, safety, and communication equipment was provided by Union Switch and Signal—Division of Westinghouse Air Brake Company.

The remote-control panel for the demonstration was located on the Larchmont, N. Y., station platform. By operating miniature levers on this way-station panel, the train responded. It moved east or west, coasted or stopped, at the will of the wayside operator with no person operating the controls on the train. The movements of the train were protected by automatic train control equipment so the train could not proceed unless conditions ahead were safe as determined by the automatic equipment.

In the 11-mile round trip between Larchmont and Rye, N. Y., the engineer at the Larchmont station controlled the car's movement, stopping it smoothly at each of the intervening stations under the radiophoned instructions of another engineer in the car. Just before the car arrived at the Rye station, the automatic train control equipment detected a mythical track obstruction, and the car was brought to a jarring halt. The electrical impulses actuating this part of the safety equipment are carried in the rails.

Remote Control Equipment

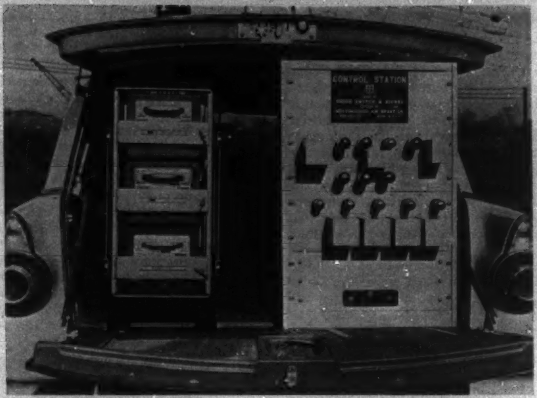
The equipment for remotely controlling the operation of the locomotive is a recent development of Union Switch and Signal and used first in classification yard service. The flexibility of application of this control equipment permits it to be used in a broad range of situations where remote control is desired.

The train-carried equipment, designed for undercar installation, is arranged to be responsive to locomotive operation controls issued from the wayside station. A visual indicator on the train displays the control commands transmitted from the wayside station and can display "brakes off," "power on—east," or "power on—west."

The wayside equipment has a locomotive control panel with two miniature-type control levers. One lever selects either "eastward" or "westward" running and the other selects between "neutral," "run," and "stop." When the lever is on "neutral," the train brakes are released and power is cut off. When the lever is turned to the "run" position, power is applied and the locomotive runs in the direction selected by the other lever. When the lever is placed in the "stop" position a service application of the train brakes follows, bringing the train to a complete stop automatically.

The electronic portion of the wayside equipment consists of a power supply, an audio oscillator, and a carrier modulator. The equipment creates a carrier frequency of 94 kc by means of an oscillator, modulates this carrier with audio frequencies of 225, 535, and 1,120 cycles and amplifies this modulated carrier to the desired level of signal current. The output of the carrier modulator is connected to the existing line wires which parallel the track. The position of the two miniature type levers on the locomotive control panel determines which audio frequencies are to be introduced onto the carrier modulator. When the lever is in the "run" position, a pair of audio frequencies is introduced into the modulator—when the lever is in the "neutral" position only one audio frequency is used—and when the lever is in the "stop" position no audio frequencies are present.

The three modulating audio frequencies mentioned in the previous paragraph are used as follows: the 225-cycle signal is sent for the train to go eastward and the 1,120-cycle signal sends the train in the opposite direction. The power or run signal of 535 cycles is transmitted in conjunction with either of the other two frequencies. When the 94-kc carrier is unmodulated, brakes are applied to the train, this being a fail-safe feature.



CONTROL PANEL for operating the train by remote control is mounted in rear of station wagon. Panel at right governs stopping, starting, forward, and reverse motions of train. Panel at left contains transmitter, receiver, and power unit. This unit will be located away from the station for directions received via telephone on station platform.

CAB SIGNAL receiving equipment in large metal case in foreground picks up coded signal by rail from the signal system already in service on the railroad and controls train. Mounted on top at the left is a four-acceptance-indicator light panel. As the receiver picks up the coded signal, visual lights show on the panel. Top is green for clear board ahead, next shows yellow over green for the signal just past, next a yellow indicator for the approach signal ahead, and bottom, red indicator which shows restrictive block and will stop the train. The second metal case at left also has a light indicator panel mounted on top which receives and interprets the controls given from the wayside station for remote control of the car on the telephone handset in center.

The control commands from the wayside station are transmitted to the locomotive through inductive coupling between the modulated carrier current flowing in the line wires and a receiving coil mounted on the locomotive. The locomotive equipment is tuned to accept and act on the received signal indications from the wayside locomotive control panel.

Automatic Control and Signal Equipment

In order that this demonstration be conducted with complete safety, the locomotive was equipped with a standard Union Cab Signal equipment. Commonly referred to as "Automatic Train Control" this train-carried equipment is continuously responsive to rail-carried currents which reflect track

Future Meetings of Other Societies

Hydraulic Institute, January 8–10, Terrace Plaza Hotel, Cincinnati, Ohio.

Second National Symposium on Reliability and Quality Control in Electronics, sponsored by Institute of Radio Engineers, January 9–10, Hotel Statler, Washington, D. C.

Society of Automotive Engineers, Inc., Annual Meeting, January 9–13, The Sheraton-Cadillac Hotel, Hotel Statler, and Detroit Masonic Temple, Detroit, Mich.

Compressed Air and Gas Institute, January 16–18, Grand Hotel, Point Clear, Ala.

Conference on the Practical Utilization of Recorded Knowledge, present and future, January 16–18, The School of Library Science, Documentation and Communication Research Center, Western Reserve Univ., Cleveland, Ohio.

12 Annual Technical Conference, Society of Plastics Engineers, Inc., January 18–20, Hotel Statler, Cleveland, Ohio.

American Society of Heating and Air Conditioning Engineers, Inc., Annual Meeting, January 23–25, Cincinnati, Ohio.

National Rural Electric Co-operative Association, 14th Annual Meeting, January 23–26, St. Louis, Mo.

American Management Association, General Management Conference, January 24–27, Fairmont Hotel, San Francisco, Calif.

The Institute of Radio Engineers, National Symposium on Microwave Techniques, February 2–3, University of Pennsylvania, Philadelphia, Pa.

8th Annual Industrial Engineering Institute, Practical Developments and Application of Industrial Engineering and Management, February 3–4, simultaneously: University of California Los Angeles, and University of California Berkeley.

Western Winter Radio-Television and Appliance Market, division of Western Home Goods Market, February 6–10, Western Merchandise Mart, San Francisco, Calif.

11th Annual Society of the Plastics Industry Conference, Reinforced Plastics Division, February 7–9, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

Pennsylvania Electric Association, Electrical Engineering Committee, Winter Meeting, February 9–10, Penn Harris Hotel, Harrisburg, Pa.

Systems Operation Committee Winter Meeting, Pennsylvania Electric Association, February 16–17, Hotel Statler, New York, N. Y.

American Institute of Mining and Metallurgical Engineers, Annual Meeting, February 19–23, Hotel Statler and Hotel New Yorker, New York, N. Y.

12th Annual National Adequate Wiring Conference, February 23–24, LaSalle Hotel, Chicago, Ill.

American Society for Testing Materials Committee Week, February 27–March 2, Hotel Statler, Buffalo, N. Y.

Passenger Car, Body and Materials Meeting, Society of Automotive Engineers, Inc., March 6–8, Hotel Statler, Detroit, Mich.

14th Annual Society of the Plastics Industry Canadian Conference, March 8–9, Sheraton-Brock Hotel, Niagara Falls, Ont., Canada

National Electrical Manufacturers Association, March 12–16, Edgewater Beach Hotel, Chicago, Ill.

National Association of Corrosion Engineers, National Conference and Exhibition, Reduction of Corrosion Losses, March 12–16, Hotel Statler, New York, N. Y.

Steel Founders' Society of America, Annual Meeting, March 15–16, Drake Hotel, Chicago, Ill.

American Trade Association Executives, Washington Conference, March 15–16, Statler Hotel, Washington, D. C.

conditions in advance of a train and the cab signal continuously indicates track and traffic conditions ahead. If the train should be moving and traffic conditions in advance are such that it is not safe for the train to continue, the brakes will be automatically applied and the train will be brought to a stop regardless of the controls being issued from the wayside station. The cab signal equipment in this demonstration is of the most modern type developed by Union Switch and Signal. For the first time it employs the use of junction-type silicon transistors in place of vacuum tubes.

Inductive Train Communication Equipment

In order to establish two-way voice communication between the train and the wayside station a standard type of Union inductive train communication equipment was installed on the train and at the wayside station. This is FM operated with a carrier of 144 kc. This equipment, like the remote control equipment, operates on the inductive principle. Known as Union ITC, this equipment permitted the person exercising the control from the wayside station to announce to the passengers on the train any change in the control function.

Converter and Noise-Suppression Filters Tested on Electronic Boat

THE MARINE MARKET has been augmented by the introduction of "Powercon" converters and "Quietone" filters designed by the Cornell-Dubilier Electric Corporation (C-D), maker of capacitors, noise-suppression filter systems, and vibrator-powered converters for converting d-c to a-c power.

An array of filtering equipment and converting units specially designed for marine service are now available to the pleasure and smaller commercial craft owners in a variety of models, according to power output capacity, heretofore found only on larger commercial vessels.

Whole areas of home electrical pleasures once unavailable because of lack of a-c commercial power on board ship are now within reach of every boatman with the use of "Powercon" vibrator converters. They are compact, completely portable devices that automatically convert 6, 12, and 32 volt d-c battery current found on pleasure craft into usable, residential-type 110-volt 60-cycle a-c electricity—the kind of power required to operate most of the common electrical and electronic devices of modern living—radio-phonographs, ship-to-shore telephones, movie projectors, food mixers, television, etc. Away from dock power, boat owners can now enjoy every one of these "comforts of home" with efficiency.

Conventional navigational equipment, fathometers, radio telephone systems, and other safety devices can likewise be readily operated from C-D "Powercons." No alteration or adaptation of the devices themselves is necessary. They simply plug into convenient receptacles on the "Powercon."

In addition, C-D is demonstrating aboard the Gypsy III extensive filter equipment developed specifically for marine use at the firm's "Interference Laboratories" in New Bedford, Mass. These "Quietone" filters guarantee, for the first time, noise-free reception aboard power-operated pleasure craft.

"Static" interference produced by motors and devices run by motors is removed or reduced to a level where it cannot interfere with the sending and receiving of radio communications. Such well-performing communications systems are particularly vital in times of emergency.

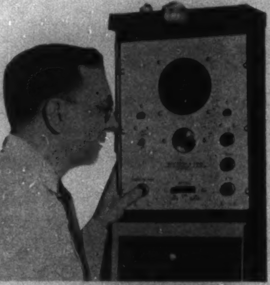
GYPSY III, a floating electronics laboratory used for testing the latest electronic marine developments of the Cornell-Dubilier Electric Corporation.

Elevator Control for Tall Television Towers

A recent development in inductive elevator control by Union Switch & Signal Division of Westinghouse Air Brake Company, Pittsburgh 18, Pa., has been installed at four stations; WWJ-TV (1,063 ft.), Detroit, Mich.; KVOO-TV (1,175 ft.), Sand Springs (seven miles from Tulsa), Okla.; WGBS-TV (996 ft.), Miami, Fla.; and WISN-TV (1,100 ft.), Milwaukee, Wis. These Union "TVL" electronic systems control the two-passenger elevators which glide up and down inside the structures.

Although an elevator in a television tower is unique, the tail-safe "TVL" system for controlling it, too, is an innovation. In place of the usual two-wire electric circuit and related equipment, control is accomplished by means of a low-frequency carrier wave on a single, three-conductor cable.

This system enables the operator to stop at any level of the tower simply by pushing a button. The only switches required on the structure are located at both terminals. Called final limit switches, they stop the car automatically when it reaches either terminal. A legal requirement in most states these switches usually are not used unless other equipment fails.



INDUCTIVE ELEVATOR CONTROL console simplifies television tower maintenance and repair, and ground control, in case of emergency.

Another feature is a separate, independent control console located at the base of the tower enabling someone on the ground to control the elevator if equipment failure or other emergency should occur. However, this console, under lock and key, is available only to authorized personnel.

The system also contains noise-free communication apparatus which insures constant voice contact between car and tower base. An integral part of the installation, it is free from radio interference and operated by push button either in the car or on console.

The transmitter, located in the elevator, provides a carrier frequency of 144 kc. It sends out tones of two different frequencies—one tone controls ascent of the car, the other controls descent. The voltage required to energize the transmitter is provided by battery located in the cab.

The receiver is installed at the lower end of the tower and, dependent upon travel direction, filters the signal and feeds it into relays which in turn control the operation of the elevator power supply.

Advantages of inductive control over conventional wire control is ability to stop or start elevator at any level of the tower without switches, special wiring, etc. Wire control, too, is unsafe and impractical because high winds or other adverse atmospheric conditions can cause damage.

Electric Wordwriter Simplifies and Speeds Typing

The Electric Typewriter Division of International Business Machines Corporation announced development of the IBM Electric Wordwriter, an experimental device which prints any one of forty-two 18-character words or phrases at a rate of more than 150 words a minute. The new machine automatically capitalizes and hyphenates words.

The Wordwriter idea was conceived by T. J. Watson, Sr., IBM board chairman, to increase accuracy, speed typewriting, and reduce typing effort. The new machine was developed by R. R. Seeber, Jr., senior IBM staff member of the pure science department at Watson Scientific Computing Laboratories, Columbia University, New York, N. Y.

The development model is a standard electric typewriter set in a center-well desk. Connected to it, out of sight in the left-hand drawer, is a memory system placed in a control panel. The typewriter retains all its normal functions and can be used for routine work. A foot switch shifts and converts it into the Wordwriter.

The machine gives typists and secretaries a chance to use stock phrases and job-jargon. Since the typist herself decides what to store in the memory unit, she fits the Wordwriter to her individual job. The task of memorizing the code is easy because the typist sets up her own coding system, choosing the letter key to represent a word or entire phrase and, thus, reducing the possibility of typing errors.

The Wordwriter's most fascinating features are: (1) Conditional hyphenation which relieves the typist of having to think of the automatically written word's position in the line, i.e., if the word "appreciate," is written at the left-hand side or middle of the line, hyphenation is disregarded and the word spelled out completely. But should it come at the end of the line, conditional hyphenation takes over, breaks the word in the right place, and completes it on the next line. (2) Optional capitalization of such phrases as "thank you for" which might occur either at the beginning of a sentence, where it requires an initial capital, or later, where it is spelled entirely in small letters. Thus, the optional capitalization feature produces a capital letter or not, depending on the phrase placement.

Since 42 words or phrases, 18 characters each, easily can be put into the memory unit, the typist obtains a "rest period" during otherwise routine work. And she can master the mechanism after a very short period of instruction.

The everyday business letter shows the machine's versatility and practicality. By pressing down the Wordwriter switch and touching the appropriate key the date line, changed by the flick of a button, is typed in its proper place and the carriage returned to the left-hand margin where the name and address are typed in by the typist. Then the salutation "Dear Mr." is automatically written and the addressee's name put in by the typist. In the body of the letter standard phraseology such as "in accordance with," "thank you for," and similar phrases are typed at the touch of the appropriate key. In the case of "thank you for" it may be the "t" key. Flexibility is apparent because any typwriter key letter could have been chosen beforehand to call the phrase from the memory unit.

At the complimentary close, the Wordwriter does some of its fastest and cleverest work. Touching the proper key for the closing, the operator can sit back and watch the machine return to the left-hand margin, space down two spaces, tabulate to the proper place on the sheet, type in the letter writer's name, move the paper up, type in his title, move the paper up again and type in the name of his department. Then, a perfectionist, the memory unit returns the carriage to the left-hand margin and types the initials of the signer and the typist. While the machine is doing this, the typist prepares her next letter.

Increased efficiency without strain is provided the typist by the Wordwriter when used in fields with special, constantly recurring vocabulary, such as psychology, medicine, law, engineering, letters of credit, invoicing, and order writing.

New Sound Laboratory at General Electric Has Noise Library

A library of noise will be one of the major results of a new sound analysis laboratory recently completed by General Electric Company at Fort Wayne, Indiana.

Recordings of the slightest murmur of electrical transformer and motors will make the "noise library" a most unique collection in existence. The recordings will be used to compare various noises, so that noise sources can be isolated and corrected.

Believed to be the largest sound room in industry with an ambient noise level of +10 decibels (as measured on NEMA-specified networks), the laboratory is a free field (anechoic) chamber exceeding the specifications recommended by the National Electrical Manufacturers Association for such tests. This is low enough to permit sound analyses to be taken on units whose acoustical power ranges from 10^{-1} watts to 10^{-9} watts, a range of 100 million to one.

All tests are made by remote control, without any person in the sound room during testing, because the human body reflects sound and is incapable of remaining absolutely motionless and silent.

The laboratory building is constructed so that its wall are not parallel to any nearby structure. This prevents outside noises from reflecting back and forth between the subsequent build-up of sound energy from outside walls.

Inside the laboratory, the sound testing chamber floats on steel springs and rubber shock absorbers, to help prevent transmission of practically any ground vibration such as would be caused by a passing train. Its walls are of 8-inch concrete, lined with 3 inches of flat mineral fiber acoustic batting. Over this layer is another 3 inches of the same material in the form of a giant wash-board with ridges 3-feet deep, covering the entire inner surface of the room from "ceiling" to "floor."

A steel ramp extends from the doorway of the chamber into the exact center of the room, on which equipment to be tested is placed. Microphones and testing instruments are suspended above the ramp, and are connected to recording equipment outside the room. In an actual test, the double doors to the room, also covered with acoustic fiber and baffling, are locked into place to insure accuracy.

To be tested in the room are G-E products manufactured at Fort Wayne including fractional and integral hp motors, and dry-type and control transformers.

ENGINEERS SET UP TEST of transformer in new General Electric Company sound laboratory, Fort Wayne, Ind. Believed to be the largest sound room in industry with an ambient noise level of +10 decibels, the laboratory makes possible sound analyses on units with an acoustical power range of 100 million to one.

ANTHONY A. GARRA, project engineer on COMAR-1, at ARDC's Wright Air Development Center, demonstrates the ease with which the portable miniaturized electronic computer's top hinges upward and its sides swing open on hinges. COMAR (Computer, Aerial Reconnaissance) speeds up reconnaissance data computation for bombing missions.

Portable Electronic Computer Developed for U. S. Air Force

Development of a portable miniaturized electronic computer to speed reconnaissance data computation for bombing missions was announced by the Air Research and Development Command Headquarters.

Present bombing techniques require considerable time to solve mathematical problems from data obtained by reconnaissance aircraft before a bombing mission can begin. The new computer will solve these problems in minutes compared to hours now required by conventional manual methods, using desk calculators.

The 550-pound, 24 cubic-foot computer was developed by the International Business Machines Corporation, for the Air Research and Development Command's Wright Air Development Center. The COMAR-1 (for Computer, Aerial Reconnaissance) was recently installed at Wright Air Development Center's (WADC) Aerial Resonnaissance Laboratory, Wright-Patterson Air Force Base, Ohio.

Pinpoint bombing depends upon precision instruments that correct for various error-producing elements present in the type of flying performed by modern aircraft.

The Air Force has long sought a computer to reduce reconnaissance computations quickly. Large-scale digital computers, already installed at several Air Force installations, are too big and complex to be moved quickly and as frequently as tactical operations may demand.

It is hoped the COMAR-1, housed in a cabinet only 47 by 23 inches and 38 inches high, will provide the answer. Small and light enough to be transported in a one-quarter ton pick-up truck, it uses standard 110 to 115 volts a-c, needs no air conditioning, and draws only $1^1/_2$ kilowatts of power, little more than a portable floor-type electric heater.

The model delivered to WADC will be used experimentally with a view toward placing small electronic computers in the field at squadron level.

Besides its flexibility, it features low cost and exceptional ease of operation and maintenance. The cabinet is hinged at one end and opens to permit easy access to all parts. Despite its small size and low cost, it has all the facilities normally found in the larger super-calculators.

The COMAR-1, a general purpose computer, also can be used for geodetic, photogrammetric, and any other computations. Project engineer on it is Anthony A. Garra, who is of WADC's Aerial Reconnaissance Laboratory Charting Equipment Section. The computer was designed and developed at IBM's Watson Scientific Computating Laboratory in New York City.

Housewife-Engineers Needed in "Automatic" Homes

Make "engineers" of the nation's homemakers of the future is the proposal of an outstanding private utility and manufacturing executive.

Young women in high schools and colleges should be taught a course in "Household Engineering," is the belief of Frank M. Tait, chairman of the board of the Dayton Power and Light Company and of the Dayton Pump and Manufacturing Company.

A young woman's formal education in home economics does not properly equip her to enjoy the "automatic" homes of the present or of those "marvels" yet to come.

These new automatic gas, electric, and electronic kitchens save hours of time and effort, but the average homemaker does not derive from an appliance all the benefits built into it by the manufacturer, because she never really gets to know the appliance.

Schools should teach the prospective bride how each appliance works and what it is capable of doing. It is suggested that some study be given waste disposal units, water softeners, irons, automatic dish and laundry washers, automatic space heating units, laundry driers, carpet sweepers, dehumidifiers, air conditioners, water heaters, incinerators, and other modern "necessities."

A homemaker should also be taught simple rules for keeping appliances in good working order. The housewife should know what she can do safely in the way of maintenance and repairs—and what should be done by professional servicemen.

A woman with some training in household engineering will be able to make a greater contribution to home life.

British Convention on "Electrical Equipment of Aircraft"

The Institution of Electrical Engineers is arranging a convention on "Electrical Equipment of Aircraft" to be held in the Institution building in London from May 2–4, 1956. About 20 papers will be presented. AIEE members are invited.

The proceedings will be opened by the president, and the provisional plans are:

Wednesday, May 2, 1956
  Evening—Session 1: Opening Session
Thursday, May 3, 1956
  Morning—Session 2: Electricity in Aircraft
  Afternoon—Session 3: Aircraft Electrical Systems
  Evening—Session 4: Installation and Maintenance
Friday, May 4, 1956
  Morning—Session 5: Machine Equipment
  Afternoon—Session 6: System Equipment

French Initiate Program to Step-up Atomic Energy Activities

The French Government has initiated a broad-gauge program affecting educational and atomic energy activities in a move to advance its position among the leading nations of the world conducting basic nuclear physics research.

A major step is the purchase of three Van de Graaff accelerators from High Voltage Engineering Corporation, Cambridge, Mass. One, a 4-million-volt unit, will be used as an injector for the proton-synchrotron being built at the Centre d'Etudes Nucleaires de Saclay (near Paris). This synchrotron, for basic physics investigations, is similar to the cosmotron used at the Brookhaven National Laboratory in the United States. In fact, it was the outstanding success of an injector developed by High Voltage Engineering Corporation for the Brookhaven cosmotron that led to purchase of the accelerator for the Saclay installation.

An even larger 6-million-volt Van de Graaff machine is to be used by the Institut de Recherches Nucleaires at France's University of Strasbourg. Projects there aimed at development of fundamental nuclear data are under direction of Professor S. Gorodetsky, and are conducted in co-operation with the French Department of Education.

The third unit, a 2-million-volt Van de Graaff, will be used in a program administered by the French Atomic Energy Commission to train physicists and engineers. This is the initial effort by France to tailor its educational programs to the needs of the nuclear age, and will be followed by an integrated training curriculum in this field to be set up in all French universities.

Electronic Sound Gauge Helps Blind To Test Production Parts

The magic of electronics is enabling blind people successfully to carry out the precision testing of close-tolerance production parts at Burroughs Corporation's main plant in Detroit.

Using an ultrasensitive electronic sound gauge, developed by Burroughs manufacturing engineers, blind employees will be able to test quickly and accurately the thousands of precision parts the corporation produces for use in its business machines and equipment.

The sound gauge, under test by Burroughs for some time, was demonstrated before production experts by Charles D. Sullivan, employment specialist for the Michigan Social Welfare Commission and Nick Sotnick, both of whom are sightless. Each learned to operate the gauge with approximately five minutes of instruction.

The gauge, about telephone size, is connected by cable to an amplifier and measures accurately to 0.0002 of an inch. Production parts are inserted into a measuring anvil. A thickness reading is taken electronically. The reading is indicated on a dial and, at the same time, is transformed into a sound tone, as well as a visual light signal.

The blind operator, wearing a head phone similar to that of a hearing aid, hears a low pitched tone for parts that are under the proper thickness and a high pitched tone for those parts over the required thickness. Parts meeting the requirements produce no tone at all.

Large-Screen Radar Display System for Normal Light Viewing

A high-brightness radar display system which projects radar images on a screen four feet in diameter and can be viewed under normal lighting conditions has been developed by the Radio Corporation of America for possible use in air traffic control and other applications where large, bright displays may be required.

The experimental system has been built around a new tube developed at the David Sarnoff Research Center of RCA at Princeton, N. J. It is described by RCA scientists as capable of providing a display many times brighter than any previously achieved on so large a screen. Where present large displays must be viewed in comparative darkness, they report that the new system permits satisfactory viewing in surroundings as brightly lighted as the average living room.

Based on a modification of the direct-viewing storage tube previously developed by RCA, under Signal Corps contract, for daylight viewing of radar images on the bridge of a ship or in an airplane cockpit, the new large-screen display involves a projection process employing a high-efficiency optical system and a rear-projection directional screen.

According to details given, the image is first produced on the face of the modified storage tube, which is four and one-half inches in diameter. The tube employs three electron guns: the first floods the luminescent face of the tube and produces an extremely bright image, the second "writes" the pattern of the picture, and the third provides an erasing beam to remove the pattern as desired. With the erasing beam, any portion of the area may be cleared instantly so that a new image may be imposed.

The projection system was described as an experimental arrangement similar to the optical system used in theater television image projection. By this means, the image on the tube face is reflected from a spherical mirror through a correcting lens to the four-foot display screen.

Trackless Cross-Country Freight Train Has All-Wheel Drive

Several types of a giant cross-country freight train promise to open new doors to the expansion of world commerce into underdeveloped areas.

One of the nation's leading industrialists and inventors, Robert G. LeTourneau, says that commerce "is about to undergo a broad extension beyond the bounds of highways and railroads" due to this new concept in transportation.

The cross-country freighters differ considerably from the railroad variety. They travel on rubber tires instead of rails, and each car is self-propelled with all-wheel drive, rather than pulled by a lead engine.

Three of the transporters already have been completed by R. G. LeTourneau, Inc., Longview, Texas. Just contracted is a fourth one for the Army Transportation Corps. Several others have been ordered by private industry for use in parts of the United States and abroad.

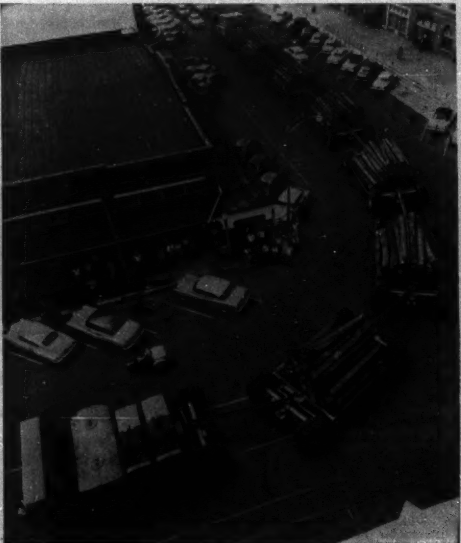
One reason the new cross-country carriers operate where other equipment will not is because of their all-wheel drive arrangement. Every wheel of every car has an individual electric motor tucked into its center. Thus, a six-car train with six wheels per car would have a 36-wheel drive.

Another reason is that tires on some of the freighters range up to 10 feet tall and 4 feet wide, offering more than 50 times the ground contact area of an ordinary automobile tire. Such size, plus the fact that the tires operate on as little as five pounds air pressure, allows the freighters to travel through sand, snow, or lowland areas where conventional equipment would bog down quickly.

Still another feature which adapts the trains to rough, rocky terrain is its flexibly mounted axles. These allow wheels to roll over such obstacles as stumps or ditches without reflecting jolts to the rest of the car.

A unique steering arrangement assures that the last car of the freighter will follow the identical tracks of the first car, regardless of how many cars may be in between. Thus, when the lead car makes a sharp turn around a given obstacle, every other car will come up to the same spot and make the same turn. The effect is that of a train being guided by permanent tracks, except these freighters choose their routes as they go.

It was pointed out that, while ordinary railroad trains require that grades be nearly level, these rubber-tired editions can climb a steeper grade than an automobile. Thus, the expense of tunneling through mountains or zig-zagging up hillsides is eliminated.



Cross-country freighter showing almost uncanny maneuverability around sharp corners. Each "trailer" furnishes its own locomotion through powerful electric motors tucked into each wheel—thus this train has 32-wheel drive. Rectangular shapes on the lead car are, from left: operator's cab with seats for 7 people, 3,500-gallon fuel tank, and 2 engines with generators to furnish power to the electrically driven wheels.

RCA and NBC Sponsored Scholarships and Fellowships

The 1955–56 academic year begins the 11th year during which RCA has supported a scholarship–fellowship plan. At the end of World War II, Brigadier General David Sarnoff anticipated the need for men and women trained in the field of electronics to carry wartime developments into peacetime commercial applications. To implement this, the RCA scholarship plan was instituted by the board of directors in 1945. The plan was extended to include graduate fellowships in 1947, and has been further expanded from time to time.

Close relationship between the electronics industry and the entertainment arts has enlarged the scope of RCA scholarships and fellowships which formerly were limited to students of science. The awards now include the fields of dramatic arts and music as well as industrial relations.

Awards of 33 RCA scholarships and 20 RCA fellowships valued at $96,400 will be made by the corporation during the 1955–56 academic year. These scholarships and fellowships are established in all classes of colleges and universities—large and small, state and also privately endowed.

Since 1945, through the grants, 193 individuals have been aided in the advancement of their education.

Fellowships are awarded for graduate study and research only in the United States, and the institution in which the Fellow studies must be approved by the RCA fellowship board.

Requests for additional information and application blanks concerning RCA fellowships administered by the National Research Council should be addressed to: Fellowship Office, National Research Council, 2101 Constitution Ave., Washington 25, D. C.

Transistorized Repeater Improves Field Telephone

An easy-to-use inexpensive device that lets a combat soldier talk farther over field wire with his phone is being perfected at the Army Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

By splicing a small rugged "repeater" into a telephone line every 6 miles, voice range is extended upwards of 30 miles. Once installed, the new device works automatically without adjustment for the life of the equipment.

Heart of the new device is a pea-sized transistor that cuts down the effect of line loss which limits the distance of voice travel.

The new device weighs a mere $3^{1}/_{2}$ pounds including case and battery. It is one fifth the size and weight of a World War II development and a postwar multitube model. These devices offset line loss by a build-up or boost of the voice, both necessarily costly and big.

In the new model, a dozen small parts fit snuggly on a simple printed circuit card. A flat plastic case seals out dirt and moisture, thus making for years of trouble-free service. The new repeater takes rough combat handling, and uses much less power. Batteries for the new device last 90 days, and cost $6 annually as against the World War II repeater's which cost about $105.

The repeater has other advantages. Where only one wartime unit could be used in a line placed mid-point in the telephone circuit, with the transistorized model, a soldier's voice can travel much farther tieing into a combat "party-line."

For flexible battlefield use, the transistorized repeater is much better than the previous models. It can be strung in a tree for camouflage, spliced in easily, or taken out of a field wire. In fast-moving combat, a single man can rapidly lay out or pick up a complete circuit by himself—a tough job at best with the older 65-pound repeater.

The new model will last 10 to 15 years in field service and needs no adjustment whereas the old models were depot repaired frequently.

This new aid to the soldier was recently tested in the Signal Corps laboratories' climatic chambers to double-check arctic cold and desert heat performance. It will be further tested in simulated combat before issue to the troops.

Low Current Units Introduced by Fedders-Quigan

One of the pioneers in air conditioning and producer of room units, introduced its 1956 line, featuring a 3/4-hp model which draws only 40 per cent of the current of conventional models.

Radically new is the $7^{1}/_{2}$ ampere "3/4 Supreme," designed to aid in the solution of the nation's wiring problems. Using 40 per cent of the current of other units, the "Supreme" puts an end to blown fuses, overloaded circuits, and many of the other traditional air conditioning difficulties. This new high-power, low-ampere model does not require special wiring costs; it plugs into any available 110-volt outlet.

The public has been warned repeatedly by utility companies of the need for special appliance circuits for air conditioners because standard home wiring is overloaded. The problem is solved by this full-power, low amperage air conditioning unit which is said to operate safely and efficiently on existing circuits.

Another new and dramatic feature is the "Electronic Purifier," available in several models, which removes up to 300 per cent more dust, pollen, and foreign particles from the air and also removes smoke from the atmosphere.

A room air conditioning window unit was introduced, too, which cools in the summer and heats in the winter—even in below-freezing temperatures. The newly developed "automatic defrost cycle" built into the unit prevents icing up by means of a power heat pump which automatically defrosts itself, and can draw heat from outside air even in 10 degree temperatures.

Autonetics Division Is Established by North American

North American Aviation, Inc., has announced establishment of the Autonetics Division for continuation of its engineering and manufacturing operations in the electromechanical field.

Developed from engineering studies inaugurated nearly 10 years ago in relation to the company's program of guided missile development, North American's work in electromechanics has grown into an operation now employing nearly 8,000 people.

The division is the outcome of the growth and continuous progress made in this field, and is developing and producing important equipment for the United States' defense program as well as automatic devices with commercial potentials

The Autonetics Division is engaged in the development and production of automatic navigational systems for both missiles and aircraft—autopilots, automatic flight control systems, airborne armament control systems, radar systems, analogue and digital computers, data processing equipment, and precision automatic controls for machine tools.

The division is producing the fire control system for the F-86K Sabre Jet, the electromechanical flight stabilizer controls for the F-100 Super Sabre, and the NADAR airborne tape recorder and two-place intercommunication units. The division also has developed NATECS, an automatic control system for emergency vehicles and traffic signals.

John B. Moore, who has been head of the company's electromechanical engineering department, has been named general manager of the Autonetics Division reporting to L. L. Waite, vice-president in charge of North American's Missile and Control Equipment operations.

The Autonetics Division will soon occupy expanded facilities now under construction near North American's Downey plant.

Staff for USNC-International Geophysical Year

The U. S. National Committee for the International Geophysical Year (USNC-IGY), has announced that the secretariat of the committee now includes the following: Executive Secretary Hugh Odishaw, Administrative Officer R. C. Peavey, and Program Officer G. F. Schilling.

The International Geophysical Year (1957–58) program is an unprecedented study of man's physical environment. More than 40 nations are participating in the co-ordinated, simultaneous geophysical investigations. The program of the United States includes the following fields: aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity measurements, ionospheric physics, latitude and longitude, meteorology, oceanography, seismology, solar activity, rocket exploration of the upper atmosphere, and the earth satellite program.

The planning of the United States' program by the U. S. National Committee has been achieved through the assistance of 14 technical subcommittees and panels, composed of specialists in the various geophysical disciplines. These groups have worked closely with the USNC Secretariat and with many public and private institutions co-operating in the USNC-IGY effort. Established by the

National Academy of Sciences, USNC-IGY is responsible for the formulation, direction, and execution of the United States program. Federal sponsorship and funds have been obtained by the Academy's committee through the National Science Foundation which is the Government agency responsible for federally supported basic research. To date, Congress has appropriated $12 million.

Signal Corps Tests Made in "Mobile Laboratories"

A fleet of 16 "Mobile Laboratories" designed and developed by the U.S. Army Signal Corps, Engineering Laboratories, Fort Monmouth, N. J., to test and improve suppression systems for a wide variety of interference producing equipments built by industry for the Armed Forces, is now in successful operation from coast-to-coast.

The unique "labs on wheels" transport test equipment and associated gear to all parts of the United States to analyze the efficiency of radio interference systems of preproduction models of vehicles, engine generators, radar equipments, etc., as they are made available for military use by contracting firms.

The traveling laboratories, operating out of Fort Monmouth, N. J., Milwaukee, Wis., and Pasadena, Calif., are manned by Signal Corps engineers, skilled in the radio interference suppression field. The new mobile workshops are converted 29-passenger buses.

On-the-spot tests are made to determine conformance to applicable suppression specifications. If found unsatisfactory, engineering design assistance is supplied the manufacturer to provide acceptable equipment with a minimum of delay.

Suppression tests are conducted in an area away from the contractor's plant where man-made interference is at a low level. Results show the new service has expedited solution of engineering problems and assisted technical services in the procurement of high priority equipments with a minimum of delay.

The traveling laboratory carries a full complement of interference measuring equipment, and a wide variety of suppression components, including capacitors, filters, feed-through capacitors, shields and shielding tools, and other items such as a workbench, report desk, reference book case, clothes-closet, and heater.

Installed also is an engine generator for the test equipment, lights, and power tools. The exteriors of the vehicles have been altered to permit easy removal of the interference measuring equipment, equipment table, extension cord, and other items.

Work on the mobile laboratory project was spurred by an Army announcement citing the necessity for applying radio interference suppression systems to all gasoline-engine-driven and electrically operated equipment.

The Army announcement said: "Radio interference, by degrading the performance of communication equipment, endangers the attainment of military objectives and the lives of personnel."

The unique service, available to all branches of the armed services, was conceived and developed by engineers of the Suppression and General Engineering Branch of Coles Signal Laboratory, a component of the Signal Corps Engineering Laboratories.

Ford Motors Establishes Atoms for Peace Awards

Dr. James R. Killian, Jr., president of Massachusetts Institute of Technology, will serve as chairman of the organization and planning committee of Atoms for Peace Awards, it was announced today by Henry Ford II.

In addition to Dr. Killian, the committee will include Dr. Detlev W. Bronk, president of the Rockefeller Institute for Medical Research and president of the National Academy of Sciences; Dr. Ralph J. Bunche, undersecretary general of the United Nations; Dr. Arthur H. Compton, professor and former chancellor, Washington University; Mrs. Douglas Horton, formerly president of Wellesley College; Dr. Mervin J. Kelly, president of the Bell Telephone Laboratories; and Dr. Alan Waterman, director of the National Science Foundation.

Atoms for Peace Awards, announced by Lewis Strauss, chairman of the Atomic Energy Commission, in Geneva on August 8, was established as a memorial to Henry Ford and Edsel B. Ford by a Ford Motor Company Fund appropriation of $1 million. It will provide $100,000 annually for 10 years to be spent in helping to provide incentives for the world's scientists, inventors, and engineers—without regard for nationality or political belief—toward finding new ways in which the atomic energy science can be used for the welfare of mankind.

"I welcome the opportunity to share in the establishment by Mr. Ford of the Atoms for Peace Awards and to work with him and the other members of the committee in planning the means for making the awards," Dr. Killian commented.

"Bold and imaginative acts to encourage and demonstrate the benign uses of science and technology, such as the President's 'Atoms for Peace' program, are top-priority items on the agenda for world peace."

Mr. Ford stated that the executive committee of Massachusetts Institute of Technology had approved his suggestion that the headquarters of the new institution be located at that campus.

The organization and planning committee, under the leadership of Dr. Killian, has agreed to undertake the planning and organization of the Atoms for Peace Awards that will best assure the use of its funds during the next 10 years toward the application of atomic energy for the benefit of mankind.

In informing Mr. Lewis Strauss of the establishment of the new institution on July 25, Mr. Ford described it as a response to the hope expressed by President Eisenhower at the July meeting of the "Big-Four" in Geneva that "private business and professional men throughout the world will . . . provide an incentive in finding new ways that this science can be used . . . for the benefit of mankind and not for destruction."

Mr. Ford said at that time, "We would propose that when the organization of this new memorial fund is completed, the Board of Trustees of Atoms for Peace Awards appoint each year a competent International Jury of Awards for the purpose of selecting from among the world's scientists, inventors, and engineers—without regard for nationality or political belief—the individual or group of individuals who, in the jury's judgment has made the greatest contribution during the year to peaceful uses of atomic energy; that the individual or group so selected be granted with appropriate ceremony the Atoms for Peace Award for that year; that the annual award carry, in addition to a suitable medal to be designed and cast for the purpose, an honorarium of $75,000; that, if during any year the International Jury of Awards or the Board of Trustees finds no candidates pre-eminently meriting the Atoms for Peace Award, the sum at the disposal of the memorial fund be used that year for scholarships and fellowships most likely to contribute to the advancement of the new science of peaceful application of atomic energy."

Union College Engineering Receives Gift Kit from IBM

An electronic computer experimentation kit, a device used for training and for development work in laboratories, has just been presented to the Electrical Engineering Department of Union College, Schenectady, N. Y., by the International Business Machines Corporation (IBM) of New York, N. Y. Union was one of six colleges so honored.

The device will give Union engineering students valuable experience in the technology and operation of digital computing apparatus, one of the major electronic developments of recent years. It will be put to immediate use this fall in the teaching of senior electrical engineering laboratory classes.

Presentation on behalf of IBM was made by two Union alumni, Mr. Bryon E. Phelps, Class of 1935, and Mr. Harold F. Heath, Class of 1951. Both currently are assigned to IBM's Poughkeepsie laboratories. Professor Clarence F. Goodheart, chairman, electrical engineering department, accepted the gift for the Union College.

Nuclear Microscope Measures Tiniest Particle

Nuclear physicists of Stanford University's High Energy Physics Laboratory are now able to examine the tiniest particles of matter through a recent development—the world's largest nuclear microscope.

Experimental work, under the Air Force Office of Scientific Research through the direction of Professor Robert Hofstadter who is director of nuclear research at the school, has proved out a previous theory that the "skin" of an atomic nucleus resembled that of a tennis ball with extremely thick fuzz. This was also true of the nuclei in gold, cobalt, calcium, and other elements tested.

This instrument consists of a 220-foot electron linear accelerator coupled to a 55-ton, 16-foot high magnetic spectrometer. This equipment, developed under Office of Naval Research, Atomic Energy Commission, and Air Force sponsorship, is capable of measuring nucleons of an atom core with an accuracy of 4×10^{-16} of an inch.

The instrument will probably be able to measure protons (smallest particles within the nucleus of an atom), as the microscope steps them up to 550 million volts, thus showing them about 100,000 times bigger.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

. . . And Our Posterity

To the President of the
American Institute of Electrical Engineers
in the Year 2055

Dear Sir or Madam:

You probably do not experience the same psychological jolt in reading the salutation to this letter that I do in writing it. At this moment in our professional history there are but few women engineers. Currently we are being faced with a critical shortage of electrical engineers occurring at the very time when anyone who attempts to see into the future would say that the almost limitless developments in electronic applications, control and communication seem to require great numbers of talented young people to enter our profession. We realize that perhaps we might have to grow at the expense of some of the other professions which may not be quite so necessary to the community. We realize that every capable high school graduate should be encouraged to proceed with his education. Simple arithmetic, however, shows that if we are to meet the demands for scientists and engineers which your generation will present to the community, we must consider doubling our basic source of supply by taking in the womenfolk. Their acknowledged superiority in intuition and flexibility of mind might very well contribute extraordinarily to the electrical engineering profession.

Many of us are concerned about the electrical engineer becoming a mere servant of a thinking machine which those who delight in pure fantasy assure us will do all the difficult intellectual labors of the future; however, the majority of us are quite sure that we are addressing you, our successors, as the continued Masters of the Machine, asserting your intellectual control over the physical universe without too much fuss and furor.

We electrical engineers have no doubt that, in the short one hundred years that lie between the time that this is written and the time that it will be read, the already large amounts of energy available for the use of each of us will be multiplied many, many times; that you, our successors, will be presenting your community with the possibility of living a kind of life scarcely limited by the necessity of physical labor.

As to communication, no great gift of prophecy is required to envision your era, in which undoubtedly the celerity and flexibility of the transmission of thought from one mind to another will be so enhanced that learning processes as well as liaison procedures will be accelerated to the point where some of the total misunderstandings of the present day can never arise.

Please remember, however, when you read back into the history of the mid-century period, that in spite of wars, depressions, droughts, and floods this generation of electrical engineers was blessed with a huge enjoyment of life with its tremendous intellectual opportunities and social and intellectual interchange.

We hope that you serve your community well; and enjoy yourselves while doing so.

Yours very truly,

M. D. HOOVEN (AM '24, M '30, F '44; AIEE President, 1955)

(Public Service Electric and Gas Company, Newark, N.J.)

Three Articles

To the Editor:

In the October issue of Electrical Engineering there were three articles of real interest to the engineer as a professional man. The articles were *The Year Ahead* by M. D. Hooven, *The Philosophy of Codes of Ethics* by L. L. Fuller, and *The Struggle for Unity* by W. B. Morton. These thoughtful papers in a broad sense cause the reader to look about himself and re-examine his cultural and professional status and what it represents. Singularly interesting was the expanded need of redefining our code of ethics that Mr. Fuller called to our attention. When this defining is carried out under the light of past accomplishments and future promises as outlined in Mr. Hooven's well-stated article we get some interesting results.

From *The Year Ahead* came the dynamic observation that the art of electrical engineering is expanding explosively, and rapidly becoming a leader in the future shaping of the world. It points up the fact that as time progresses engineers will necessarily have to assume heavier responsibilities in the development of our present day technological culture. Even at the passing of the hour the related engineering and scientific professions form the largest single segment of professional talent, larger even than the ministry, medicine, and law combined.

At the present moment engineering is indeed a growing giant, a fact that is causing much of the finest talent in young people to take engineering and science courses. This indicates that the intellectual leadership of the next generation should well be influenced and filled from the ranks of the engineers and scientists. With this significant realization it is vitally important that engineering ethics be given the appraisal Mr. Fuller outlined.

Electrical engineering ethics should be established from a broad and expansive point of view. They must be placed at the highest standard, a standard so high and so broad that the entire engineering and scientific profession can unite beneath. A code of ethics under which the engineering profession can operate is a prerequisite to the desirable type of unity that has been called for by Messrs. Hooven and Morton of AIEE and Ryan of the ASME.

To establish this desirable level for ethics we must (in the words of Mr. Fuller) define "The peculiar function which the engineering profession performs in the total process of society." Certainly this function has been illuminated in Mr. Hooven's cogent remarks. Who would question that the expanding of our cultural heritage is the foremost basic result of the entire engineering and scientific profession? This result is not only fundamental, but also of such singular mature stature that it can make us feel a considerable inward achievement as a group. The gigantic strides that science and engineering are making as time unfolds can truly leave little to be desired by any critics.

That the members of the AIEE recognize their basic function was indicated by Mr. Hooven. He reported that almost 50%, the largest single category of members, considered advancement of knowledge over improvement of status as the most important function of AIEE. This spells out the fact that we electrical engineers do not desire to perform in the cold light of self interest as certain other professions have chosen to do. It calls to point the recognition that we who contribute so much to the cultural advancement should rise above the peculiar position to self glorification and let our accomplishments speak for us.

With these thoughts in mind let us now consider the field of ethics. Ethics deals with relations of human beings. Ethics must necessarily come from the humanistic part of our humanistic-technological culture. What ethical restraints should be observed are necessarily dictated by humanistic considerations. Now, if we are to look over our humanistic culture for current ethical theory we are indeed left at the loss so ably pointed out by Mr. L. L. Fuller. Very little real guidance of a current nature is available. What Mr. Fuller has suggested is that we duplicate the current conventional pattern and float on the uneasy ethical sea of "the enlightened and tolerant partisanship." This conventional type of ethics would seem to leave something to be desired.

However, to interpret the fact that the lack of current guidance means no real fundamental guidance exists would be to throw away a large and significant part of our humanistic cultural heritage. Ethical guidance does exist and it is of long standing. The humanistic teachings of our religions are guidance that has withstood the onslaught of time. And just now, in our age of 20th century people, are the meanings of the human considerations as taught through the centuries now being more fully explained by our contemporaries. These religious teachings of human relations which form such an important part of our culture must necessarily be the ground work for our ethics.

In a culture expanding so rapidly technologically what more significant group could come forward to more clearly define ethical standards than the AIEE. The approach toward electrical engineering ethics is one that should elevate the profession above conflict with other professions. It should point the way for men as engineers to rise above conflict. With ethical standards of this class we can be truly diligent and faithful to our mission of a greater culture.

This approach is the ground work of true democracy, for the goals are set and striven for by ourselves. The nature of this approach is as mature as it is realistic—and realism for a mature engineer is an every day occurrence.

Because this concept of ethics which springs from the electrical engineers themselves has some basic and fundamental differences with that proposed by Mr. Fuller I felt it was worthy to submit it to your attention.

Very truly yours,

JOHN READ (AM '54)

(General Electric Company, Chicago, Ill.)

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

AN ANNOTATED BIBLIOGRAPHY ON NOISE, ITS MEASUREMENT, EFFECTS AND CONTROL. Industrial Hygiene Foundation of America, Inc., Mellon Institute, 4400 Fifth Avenue, Pittsburgh 13, Pa., 1955. 364 pages, 8$^{7}/_{8}$ by 6$^{1}/_{8}$ inches, paper. $7.50. Over 2,000 references are arranged chronologically under subject subdivision of four major sections: noise measurement, effects of noise, measurement of hearing loss, and noise reduction and control. Most of the references are from the period 1927–1953 and include foreign titles as well as English.

CONNECTING AND TESTING DIRECT CURRENT MACHINES. By F. A. Annett and A. C. Roe. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., third edition, 1955. 313 pages, 9$^{1}/_{4}$ by 6$^{1}/_{4}$ inches, bound. $5. This is a practical book dealing with methods for reconnecting for changes in voltage or speed, or both, and with methods and devices for locating and correcting faults. The book includes material on types of windings, types of coil, changing generators to motors, changing a series motor to a shunt, etc., and special emphasis is placed on increasing machine ratings by changing conductor sizes and insulation. The new edition has been revised to include recent advance.

ELECTROMAGNETIC PRINCIPLES OF THE DYNAMO. By E. B. Moullin. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y., 1955. 367 pages, 9$^{1}/_{2}$ by 6$^{1}/_{4}$ inches, bound. $8. This companion volume to the author's "Principles of Electromagnetism" approaches the subject as a training in logical thought, not as a manual of dynamo design. It aims at a thorough theoretical grounding which will encourage the student to take a critical view of the principles involved. Although chiefly concerned with d-c machines, much of the treatment is equally applicable to a-c machines.

FIFTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION. Combustion in Engines and Combustion Kinematics. By the Standing Committee on Combustion Symposia of the Combustion Institute. Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y., 1955. 802 pages, 10$^{1}/_{4}$ by 7 inches, bound. $15. Forty-five of the 101 papers in this volume are concentrated on the chemical kinetics of combustion reactions, with half of these devoted to the combustion of hydrocarbons. Of the remaining papers, 14 are on engine combustion; 20 on droplet burning, liquid propellants, and solids; and 16 on diffusion flames special techniques, spectra, and dissociation energies. The papers are fully illustrated and list references.

HANDBOOK OF ENGINEERING MATERIALS. Edited by Donald F. Miner and John B. Seastone. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1955. Various paging, 8$^{1}/_{2}$ by 5$^{1}/_{2}$ inches, bound. $17.50. Designed to meet the need of engineers for a convenient single source for data on the usual materials of manufacturing and construction, this handbook gives essential information concisely and suggests sources of more complete information. Arrangement is by classes of related or similar materials under three broad groups—metals, nonmetals, and construction materials. In general, information given includes grades, properties, applications, sources of supply and, where pertinent, design, fabricating, and other data. The first section provides general information on specifications, standards, constants, etc., and there is a detailed subject index.

HAWLEY'S TECHNICAL SPELLER. Compiled by Gessner G. Hawley and Alice W. Hawley. Reinhold Publishing Corporation, 430 Park Avenue, New York 22, N. Y., 1955. 146 pages, 7$^{1}/_{2}$ by 5 inches, bound. $2.95. This book contains over 8,000 technical words selected from the vocabularies of chemistry, physics, electronics, biology, medicine, engineering, and other fields of science and technology. Recommended word divisions are indicated.

IMPURITIES AND IMPERFECTIONS. American Society for Metals., 7301 Euclid Avenue, Cleveland, Ohio, 1955. 231 pages, 9$^{1}/_{4}$ by 6 inches, bound. $6.00. The 12 papers given at an ASM seminar present background information on the three major types of imperfections—lattice vacancies, dislocations, and grain boundaries; discuss the effects of impurities and imperfections on metallurgical properties and reactions; and treat a few special aspects such as semiconductors, ionic crystals, and radiation effects.

INDUSTRIAL POWER SYSTEMS HANDBOOK. Edited by Donald Beeman. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1955. 971 pages, 9$^{1}/_{4}$ by 6$^{3}/_{4}$ inches, bound. $12.50. Modern engineering practice in the design of electrical facilities for industrial plants and commercial buildings are covered in 17 chapters which were prepared by many contributors. The book deals with economic aspects of the subject as well as with technical problems of short circuit protection, voltages, grounding, and system design.

MAGNETIC MATERIALS IN THE ELECTRICAL INDUSTRY. By P. R. Bardell. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y., 1955. 288 pages, 8$^{3}/_{4}$ by 5$^{3}/_{4}$ inches, bound. $10. One of the primary aims of this book for students and for engineers in industry is to link the properties of the materials considered with their applications. The book deals with magnetic theory; the historical development, application, and testing of soft magnetic materials and permanent magnets; and with such special devices as sound recorders, nondestructive testing equipment, transductors, and transducers.

PROFESSIONAL DEVELOPMENT—THE RESPONSIBILITY OF INDUSTRY AND THE ENGINEER, CONFERENCE PROCEEDINGS. National Society of Professional Engineers (NSPE), 1121 Fifteenth Street, N.W., Washington 5, D. C., 1955. 56 pages, 9$^{1}/_{2}$ by 6$^{3}/_{4}$ inches, paper. $4. (NSPE members $2.) These proceedings contain five papers dealing with industry's responsibilities to the engineer, the development and utilization of engineers in industry, the need for engineer-industry cooperation, the engineers' responsibility to industry, and the role of engineering education in engineer-industry cooperation. The transcript of a panel discussion covering various aspects of these topics is also included.

TABLES OF THE CUMULATIVE BINOMIAL PROBABILITY DISTRIBUTION. (Annals of the Computation Laboratory, volume 35.) Harvard University Press, Cambridge 38, Mass., 1955. 503 pages, 10$^{3}/_{4}$ by 8 inches, bound. $8. This volume greatly extends the range of tabulation of the mathematical function which represents the probability that at least r successes will occur in a given number of trials. The introduction gives the mathematical background, describes interpolation methods, and discusses 17 typical applications, for example, in sampling and quality control work.

X-RAY DIFFRACTION BY POLYCRYSTALLINE MATERIALS. Edited by H. S. Peiser, H. P. Rooksby, and A. J. C. Wilson. Institute of Physics, London, England, 1955. 725 pages, 10 by 6$^{1}/_{4}$ inches, bound. 63s. The first two parts of this advanced treatise are devoted to the discussion of experimental techniques and equipment and to the interpretation of data. The third part deals with the practical uses of the techniques in a number of fields including mineralogical research, refractories and ceramics, metallurgical research, and atomic energy research. The individual chapters have been written by some 30 of the members of the X-ray Analysis Group of the Institute of Physics.

PAMPHLETS

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

1950–1951 Bibliographic Survey of Corrosion. This survey was made by the National Association of Corrosion Engineers (NACE). Summaries of 4,454 corrosion and corrosion prevention articles, books, and brochures published in 1950–51 are compiled in this volume. Bulletins published by 30 abstracting agencies were canvassed regularly for material taken from more than 500 sources the world over. The eight main groups treated are: general, testing, characteristic corrosion phenomena, corrosive environments, preventive measures, materials of construction, equipment, and industries. Each main group is subdivided. Topical cross references are appended to each section. A subject index, in addition to classifying literature in the field of corrosion topically, lists many metals and alloys by trade name and indexes them as to specific properties and to behavior in specific media. There are more than 4,000 names in the author index; companies and associations are not listed. References are to the classification and serial numbers of each abstract. The appendix aids the user in locating and obtaining copies of unfamiliar foreign or domestic journals. 430 pages. Per copy: nonmembers NACE $12.50; members $10. Available from National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Tex.

Techniques of Plant Maintenance and Engineering—1955. The book is a report of the proceedings of the annual conference held concurrently with the Plant Maintenance and Engineering Show. A highlight of the volume is the text of more than 1,000 questions presented by 2,400 executives to the 56 experts, drawn from the nation's leading industrial plants, who led the discussions. The question-and-answer section of the book gives a picture of current maintenance problems being faced by the nation's plants. Twenty-three prepared papers were presented and all of them are included with full text, as well as with questions which followed. Sixteen roundtables, without prepared papers, are summarized. Five industries given special attention were chemical, food, paper mill and paper products, steel, and textile. 218 pages with 61 charts and diagrams. The book, which is sent without charge to those who attended the conference in Chicago last January, may be obtained for $7.50. Send order to Clapp and Poliak, Inc., 341 Madison Avenue, New York 17, N. Y.

F35-B Magnecord Citation Tape Recorder. This booklet describes the F35-B Magnecorder, a new 2-speed, full-frequency range tape recorder for home, school, and business use. At 7$^{1}/_{2}$ inches per second, frequency response is from 50 to more 10,000 cycles; at 3$^{3}/_{4}$ inches per second, frequency response is from 50 to more than 5,000 cycles. The Magnecord meter indicates proper volume setting, and eliminates distortion and hard-to-erase tapes. Also included is a full 10-watt amplifier-speaker system in a single case. Send 25c to Advertising Department, Magnecord, Inc., 1101 S. Kilbourn Avenue, Chicago 24, Ill.

Application of Transistors to Electronic Counting Equipment. This Research Report, PB 111610, describes the construction of a frequency meter which uses transistors instead of vacuum tubes. Prior to construction of this electronic counter, a year was devoted to background study, transistor switching circuit study, decade counter development, control circuit development, and frequency meter design. The complete frequency meter was then designed and built using plug-in construction and all-transistor circuitry, and the equipment was tested. The project extended from July 1, 1952 to November 25, 1953. Results of the studies, details of design and construction of the frequency meter, and conclusions arrived at as to transistor application are given in this report. 77 pages with circuit diagrams, $2. Research report CTR-310 on the transistor. 10¢. Send orders to Office of Technical Service, U. S. Department of Commerce, Washington 25, D. C.

Units of Weight and Measure—Definitions and Tables of Equivalents. This publication, superseding Miscellaneous Publication 121 issued in 1936, defines the units of length, mass, area, volume, and capacity in use in the United States. It also gives tables of interrelation and tables of equivalents for these units in the metric system and in the U. S. customary system. In addition, the volume contains sections of the fundamental equivalents, the approved spelling and abbreviation of each of the most common units of weight and measure, and the status of the metric system in the United States. All of the tables and other material have been revised to conform to current definitions, equivalents, and usages. Conversion tables are confined to simple units, excluding all compound units such as foot-pounds, pounds per cubic foot, and feet per second. For this revision, tabular values involving the liter have been changed to the basis 1 liter = 1.000028 cubic decimeters and the international nautical mile of 1,852 meters, as adopted by the Departments of Defense and Commerce on July 1, 1954, has been substituted for the U. S. nautical mile. The publication should prove useful in scientific, industrial, commercial, and other fields. 64 pages. 40¢. Order from the Government Printing Office, Washington 25, D. C.

Use and Theory of the Analog Field Plotter. This literature describes in detail, methods used to set up and solve graphically, problems, involving flow patterns, potential gradients, flux distribution, etc., associated with highly complex shapes. The methods described can be adopted to the solution of engineering problems involving thermal, fluid, magnetic, and electric parameters. This book is profusely illustrated and contains examples of solutions to some of the many problems which can be solved by the Analog Field Plotter. 50 pages. $2.50. Address order to IM24, Sunshine Scientific Instrument, 1810 Grant Avenue, Philadelphia 15, Pa.

A Review of the Air Force Materials Research and Development Program. One hundred and thirty reports of research done under the Air Force's materials research and development program from July 1, 1953 to June 30, 1954 are abstracted in a report, PB111648. Prepared by Wright Air Development Center, this report contains abstracts of research in metallurgy, textiles, petroleum products, structural materials, rubbers, plastics, packaging, protective treatments, and analysis and measurements. 105 pages. $2.75. Order from Office of Technical Services (OTS), U. S. Department of Commerce, Washington 25, D. C. This report is supplementary to a larger report, PB111537, covering the previous 10 years of Air Force materials research. This earlier volume, with the same title but identified by code number PB111537, is still available. $3.75.

Infrared: A Library of Bibliography. Compiled by the Library of Congress under Office of Naval Research contract, the bibliography, PB111643, includes all references to published literature on the subject from 1935–51 which were found by systematic search of available sources. The classification proceeds from infrared theory and general infrared-optical properties through the various elements and components of infrared equipment, infrared spectroscopy and photography, to its various applications in science, technology, the arts, and industry. 374 pages. $3. Order from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

Power & Gas Tubes. This booklet (Form No. PG-101B) contains technical data on 178 vacuum power tubes including forced-air-cooled and water-cooled types ranging in output capability up to 500 kw; gas, mercury-vapor and vacuum rectifier tubes; gas and mercury-vapor thyratrons; ignitrons; magnetrons; and vacuum-gauge tubes. Each tube type is covered by a text description, tabular data, and a base or envelope connection diagram. In addition, photographs are shown for representative tube types. 24 pages. 20¢. Order from Commercial Engineering, Tube Division, Radio Corporation of America, Harrison, N. J.

Tests for Porcelain Insulators for Overhead Lines. Porcelain insulators for overhead lines have concerned the International Electrotechnical Commission (IEC) for more than 25 years. This group, representing 30 nations, develops international standards to further world exchange of electrical products. The United States National Committee of the IEC, arm of the American Standards Association, represents U. S. industry in international work. In 1954, 18 countries represented on an international committee voted to publish as an international specification their findings on insulators. The resulting publication, contains recommended tests for the correct dimensions of the insulators, for performance, and tests for quality to determine defects that may have occurred in the manufacturing process. The tests for dimensional requirements include data for the impulse flashover test, dry-one-minute-power-frequency test, and the wet - one - minute - power - frequency test. Judging the quality of material and how it performs may be accomplished by using tests described in the international specification, such as the temperature-cycle test, 24-hour mechanical test, short-time electromechanical breaking load test, puncture test, and the porosity test. There are two appendixes, one on humidity correction factors for flashover voltages, the other on the method of producing artificial rain for testing the insulator's wet-weather endurance. A graph of correction factors for impulse and power-frequency flashover voltages is also included. The text is in French and English. 40 pages. $2.40. Available from the American Standards Association, 70 East 45 Street, New York 17, N. Y.

Lighting Fixture Guide. According to the General Electric Company, approximately 70,000 lumens, or units of light, are needed to light-condition a 1,000-sq-ft home, and about half of these lumens should be provided by 20-to-25 lighting fixtures. The rest of the light is provided by portable lamps. To aid in the selection of the right lighting fixture for the right place in the home, General Electric has issued a booklet "Lighting Fixture Guide." The guide is expected to be of special value to fixture distributors and retailers in stocking, displaying, and selling; to utilities in helping homemakers select and buy fixtures which meet their seeing needs and decorative tastes; and to manufacturers in producing, presenting, and selling fixtures which can be fitted into the light conditioning program. For each part in the house the booklet gives lumen and recipe information for lighting an area or a seeing need; shows a variety of fixture types available to fill each recipe; and illustrates widely used styles within which to form correlated ensembles of fixtures. In addition, this booklet contains sections on desirable fixture design qualities, wiring circuits, and General Electric bulbs and tubes. 40 pages. 50¢. Send order to General Electric, Nela Park, Cleveland 12, Ohio.

Point-to-Point Radio Relay System—44 MC to 13,000 MC. A new manual on wave propagation and other aspects of vhf and microwave radio relay systems has been prepared by the Government Service Department of the Radio Corporation of America (RCA) Service Company, Inc. Containing a vast number of charts, curves, and nomograms for fast and easy calculating, the manual has chapters devoted to such subjects as "Basic Wave Propagation," "Path Attenuation," "Fading," "Weather versus Propagation," "Siting," "Interference," "Ionospheric Transmission," and other technical points. 226 pages. $2 each. For training purposes in quantities of ten or more, the reduced price is $1.80 each. Send order to the Government Service Department, RCA Service Company, Inc., Camden, N. J.

Progress through Invention. This booklet contains reprints of talks given at the first Invention Exhibit and Conference held by the Cleveland Engineering Society. Six authorities cover various phases of the need for inventions, how to invent, how to patent ideas, and how to sell them. 28 pages. $1. Available from the Cleveland Engineering Society, 2136 East 19th Street, Cleveland 15, Ohio.

Oil Immersed

Safety Line Disconnect Switches

620 Series

30-60-100-200-400 amp. available for 250 and 600 volt service

Rowan Series 620 Fused and Unfused Safety Switches are designed to provide dependable service in all locations, especially those where the atmosphere is corrosive, as in chemical plants, oil refineries, steel or cement mills.

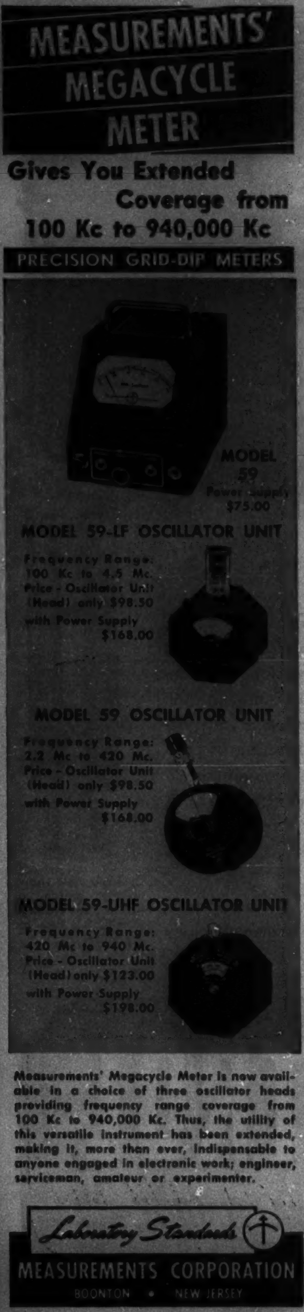
Switches are supplied with cast iron tops and welded steel tanks; special floor-mounted units are made of high quality steel. Enclosures are NEMA Type XI . . . also available in NEMA Type VIII in which all electrical connections are at least 6 inches under oil.

Standard features of these units include the following: completely oil immersed; equipped with Rowan time-tested AIR-SEAL fuses; disconnect switch of the quick-acting contactor type with renewable contacts; top and tank mechanically interlocked with disconnect switch to prevent lowering of tank when switch is in the closed position; provision for padlocking disconnect switch in OFF position; weather resistant enclosing case; provision for lowering tank for inspection without removing tank.

Complete information available from Rowan representatives located in principal cities throughout the country.

Cutaway view shows unique design of Rowan low-voltage AIR-SEAL fuse for use under oil.

ROWAN CONTROL


MEASUREMENTS'
MEGACYCLE
METER

Gives You Extended Coverage from 100 Kc to 940,000 Kc

PRECISION GRID-DIP METERS

MODEL 59
Power Supply
$75.00

MODEL 59-LF OSCILLATOR UNIT
Frequency Range:
100 Kc to 4.5 Mc.
Price - Oscillator Unit (Head) only $98.50
with Power Supply
$168.00

MODEL 59 OSCILLATOR UNIT
Frequency Range:
2.2 Mc to 420 Mc.
Price - Oscillator Unit (Head) only $98.50
with Power Supply
$168.00

MODEL 59-UHF OSCILLATOR UNIT
Frequency Range:
420 Mc to 940 Mc.
Price - Oscillator Unit (Head) only $123.00
with Power Supply
$198.00

Measurements' Megacycle Meter is now available in a choice of three oscillator heads providing frequency range coverage from 100 Kc to 940,000 Kc. Thus, the utility of this versatile instrument has been extended, making it, more than ever, indispensable to anyone engaged in electronic work; engineer, serviceman, amateur or experimenter.

Laboratory Standards
MEASUREMENTS CORPORATION
BOONTON • NEW JERSEY

INDUSTRIAL NOTES ...

Stromberg-Carlson Builds Radar Indicators. Three of the largest radar indicators ever built to meet military specifications have been completed by Stromberg-Carlson, a division of General Dynamics Corporation. The indicators, which took 18 months to construct, were designed by the company's electronics engineering department, under the direction of Charles W. Finnigan, chief engineer. Arthur Zefting was project supervisor, assisted by George Robertson. The indicators have 22-inch viewing tubes, with a maximum range of 300 miles and a minimum range of 4 miles. They can be used with any standard United States Navy radar equipment. One of the indicators has been scheduled for installation on the battleship *USS Mississippi*. The others have been shipped to undisclosed destinations. Two Stromberg-Carlson engineers are shown with one of the radar indicators.

New Division. The consolidation of all electronic computer and tabulating machine operations into a single unit to be known as the Univac Division has been announced by Remington Rand, Division of Sperry Rand Corporation, William C. Norris, vice-president of Remington has been named general manager. The new division will integrate all research, manufacturing, and sales and service functions of the Eckert-Mauchly Division at Philadelphia, Pa., the Engineering Research Associates Division at St. Paul, Minn., the Laboratory for Advanced Research at Norwalk, Conn., and the Tabulating Division of Remington Rand, New York, N.Y.

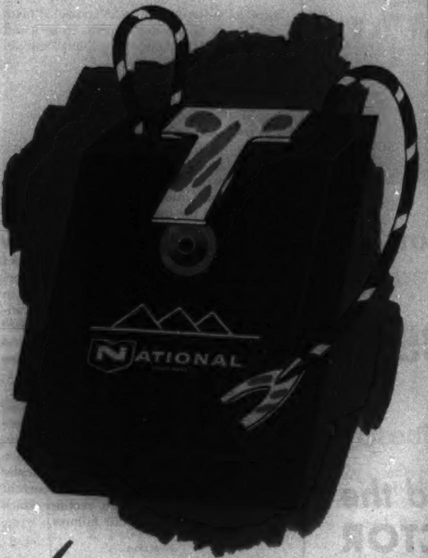
Separate Atomic Division. Looking toward the potential world market for commerical nuclear reactors, North American Aviation has established Atomics International as a separate division to handle all of the company's nuclear engineering and manufacturing operations. North American's Atomics International Division is headed by Dr. Chauncey Starr, vice-president and general manager, who has directed North American's vast atomic energy research and development program for nearly 10 years. Atomics International employs about 800 scientists, engineers, technicians, and administrative people, and will occupy a new $1.5 million building in the Canoga Park section of the San Fernando Valley in California.

New Manufacturing Technique. A manufacturing technique for practical mass production of a new transistor has been developed by Motorola, Inc. The new transistor, of a diffused base type, offers performance potential in the very-high-frequency and ultra-high-frequency ranges up to 1,000 million cycles per second. With the achievement of a manufacturing technique suitable for mass production of the new transistor, practical application of this transistor to military electronics gear, home and car radio, and television now becomes possible. The manufacturing technique for the diffused-base transistor consists of evaporating the donor "impurity" under controlled conditions permitting it to penetrate the single crystal germanium slab. Motorola's future plans call for pilot production of the new transistors at a rate adequate for extensive laboratory circuitry exploration, development of devices, and field testing. Meanwhile, construction of a $1.5 million factory facility for mass production of transistors in Phoenix, Ariz., is in process.

RCA Links Atlantic and Pacific Tex Circuits. Linking of the Atlantic and Pacific networks of the Overseas Teleprinter Exchange Service (TEX) of RCA Communications, Inc., through operating terminals in New York, N. Y., and San Francisco, Calif., has been announced. Simultaneously, RCA extended a TEX circuit to the Philippines, adding it to the Pacific network. This interconnection of RCA's two transoceanic TEX networks, now makes possible commercial teleprinter exchange service between subscribers in the Caribbean area, across the Atlantic in Europe and Africa, and those in trans-Pacific locations.

Transistor-Operated Torpedo Control. The Bureau of Ordnance, United States Navy, has announced the development of a new ultrasonic control system for torpedoes, in which, transistors are used to replace completely the usual assortment of electronic tubes. Developed by scientists at the Westinghouse Research Laboratories, the fully transistorized system brings to torpedo control all the proved advantages of transistors including extreme ruggedness, small size, high reliability of operation, and low electrical power requirements. Purpose of the control is to direct automatically the path of a torpedo to an enemy target. It does this by utilizing sound waves in the water. Once the

(*Continued on page 20A*)



✓ BEST BRUSH... ✓ BEST BRUSH LINE...

NATIONAL BRUSHES

TRADE-MARK

Your best bet, *from individual application to your entire mine or mill requirement,* is "National" brushes...best because they give you maximum machine efficiency at minimum brush cost.

Here's why:

PROVED GRADES

Grades to suit every operating condition... widest selection in the industry.

RESEARCH AND DEVELOPMENT PROGRAM

Active, sustained program assures new brushes for new-design machines; continually improved brushes for existing machines.

TECHNICAL SERVICE

Helps you get best electrical performance and reduce maintenance costs...streamlines brush-buying practice.

Start saving brush dollars now in operation, ordering and handling...Specify "National" brushes and be confident of top performance throughout your mine or mill.

The term "National", the Three Pyramids Device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd St., New York 17, New York
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco
IN CANADA: Union Carbide Canada Limited, Toronto

Here is a
SATURABLE
REACTOR
you should
know about!

It is called the
SELIN REACTOR

—and has these advantages:

LOAD CURRENT WITH MINIMUM HARMONIC DISTORTION ....

LOW DC POWER REQUIREMENT ....

FAST RESPONSE ....

DO you have an application where a sinusoidal load current is desired?

DO you need to reduce control power requirements?

WOULD it help if you could speed up response time?

The Hevi Duty-Selin Reactor may be the answer to your Saturable Reactor problem.

Write to the "Regulator Division" for further information about this important development. (Pat. applied for)

HEVI DUTY ELECTRIC COMPANY
HEAT TREATING FURNACES HEVI DUTY ELECTRIC EXCLUSIVELY
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS
MILWAUKEE 1, WISCONSIN

Industrial Notes

(Continued from page 18A)

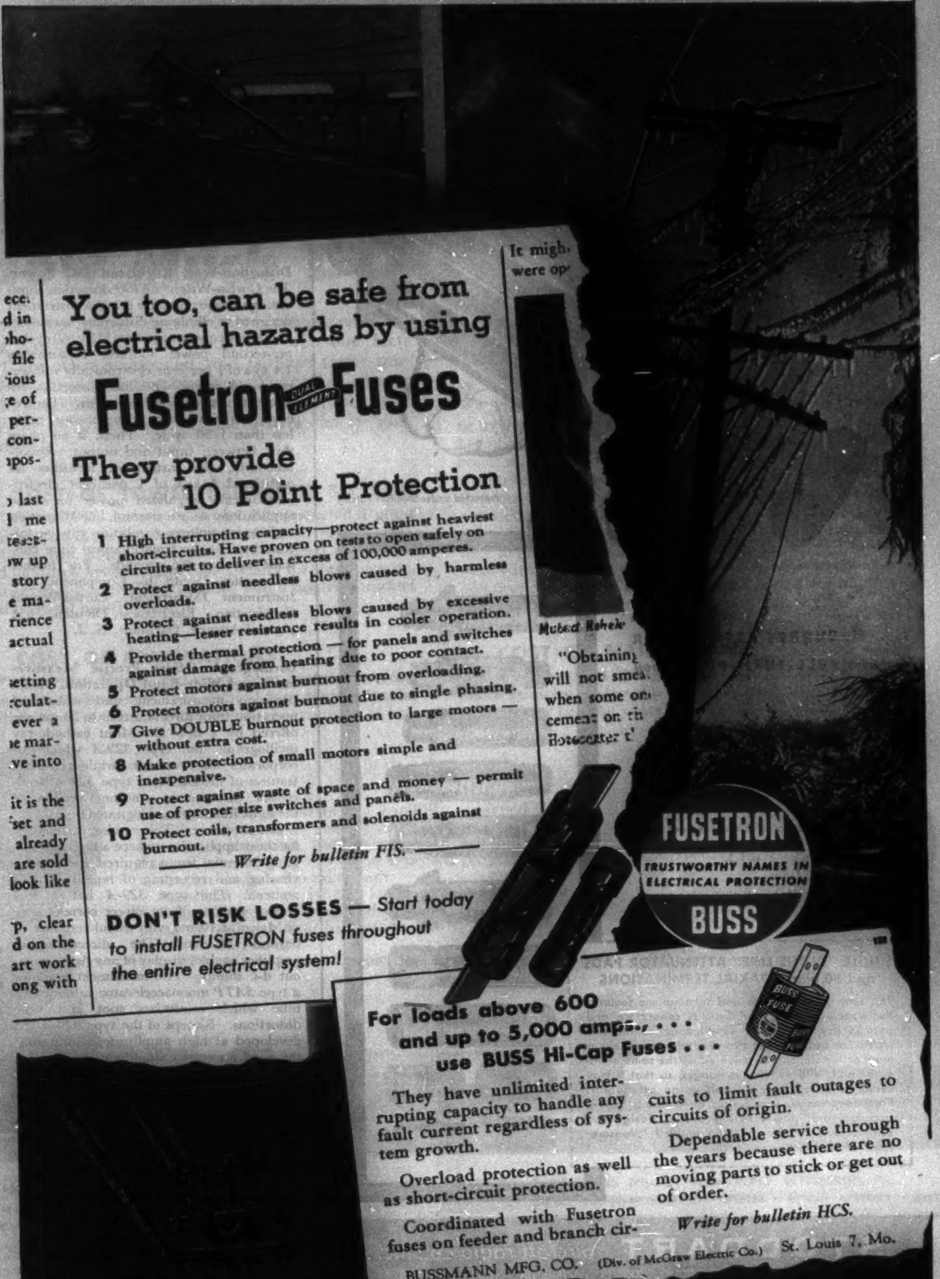
torpedo is launched, the control "takes over" and causes the torpedo to seek out and follow its target without human assistance.

Bogue Surplus Static Rectifier. Bogue Electric Manufacturing Company has announced that two giant 480 kw static rectifier supplies have been built by them for Union Carbide Nuclear Corporation, Division of Union Carbide and Carbon Corporation for use at the Atomic Energy Commission installation at Paducah, Ky. Used to supply controlled direct current power, the new static rectifier supplies provide the necessary energy for depolarizing large electrolytic cells employed in the production of fluorine. The advantages of the new static rectifier supplies are: no special foundations required; no moving parts, vacuum tubes, or water cooling equipment necessary; and precision stepless voltage control over the complete output range accurately controlled and metered from local and remote locations. From the standpoint of safety, the supplies incorporate features which permit the power supplies to automatically shut-down instantly in the event of current or voltage overloads, high rectifier stack temperatures or cooling-air failures.

Du Mont Moves to Larger West Coast Headquarters. The West Coast headquarters of Allen B. Du Mont Laboratories, Inc., went into operation this week at 11800 West Olympic Boulevard, Los Angeles, Calif. The modern new plant provides six times as much space as the facilities formerly used. It contains approximately 30,000 square feet, its own railroad siding, and ample parking area. In the new plant will be consolidated the expanded research and development engineering program, test equipment for guided missiles, and commercial and Government contract work. Du Mont's home office and four other manufacturing plants are located in New Jersey.

Belco Water Treating Plant at Texas City. A fully automatic demineralization plant has been designed and built by the Belco Division of Bogue Electric Manufacturing Company for the Monsanto Chemical Company plant at Texas City, Tex. This Belco demineralization system will supply the equivalent of triple-distilled water to the boilers at Monsanto's power plant at a rate of one-half-million pounds per hour. The complete system was designed and engineered by Belco for the Texas City plant. The control panel, stands 7 feet 9 inches high, and is 33 feet long. The control panel shows at a glance the flow pattern in any portion of the demineralization plant by means of the lighted "flow diagram" made up of flat plastic strips, each colored for a particular type of flow. The control panel board, weighing approximately five tons,

(Continued on page 28A)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FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS
BUSS FUSE

You too, can be safe from electrical hazards by using

Fusetron DUAL ELEMENT Fuses

They provide 10 Point Protection

1 High interrupting capacity—protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.
2 Protect against needless blows caused by harmless overloads.
3 Protect against needless blows caused by excessive heating—lesser resistance results in cooler operation.
4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5 Protect motors against burnout from overloading.
6 Protect motors against burnout due to single phasing.
7 Give DOUBLE burnout protection to large motors — without extra cost.
8 Make protection of small motors simple and inexpensive.
9 Protect against waste of space and money — permit use of proper size switches and panels.
10 Protect coils, transformers and solenoids against burnout.

Write for bulletin FIS.

DON'T RISK LOSSES — *Start today to install FUSETRON fuses throughout the entire electrical system!*

For loads above 600 and up to 5,000 amps., . . . use BUSS Hi-Cap Fuses . . .

They have unlimited interrupting capacity to handle any fault current regardless of system growth.

Overload protection as well as short-circuit protection.

Coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuits of origin.

Dependable service through the years because there are no moving parts to stick or get out of order.

Write for bulletin HCS.

BUSSMANN MFG. CO. (Div. of McGraw Electric Co.) St. Louis 7, Mo.

PRECISION
ATTENUATION
TO 3000 mc!

Protected under Stoddart Patents

six-position
TURRET ATTENUATOR
featuring PULL-TURN-PUSH *action*

FREQUENCY RANGE: dc to 3000 mc.
CHARACTERISTIC IMPEDANCE: 50 ohms.
CONNECTORS: Type "N" Coaxial female fittings each end.
AVAILABLE ATTENUATION: Any value from 1 db to 60 db.
VSWR: 1.2 max., dc to 3000 mc/s, values from 10 to 60 db. As value decreases below 10 db, VSWR increases to not over 1.5.
ACCURACY: ± 0.5 db.
POWER RATING: One watt sine wave power dissipation.

SINGLE "IN-THE-LINE" ATTENUATOR PADS and 50 ohm COAXIAL TERMINATIONS

This new group of pads and terminations features the popular Type C and Type N connectors, and permits any conceivable combination of the two styles. For example, the two connector types, either male or female, can be mounted on the same attenuator pad, with or without flanges, so that it may serve as an adapter as well as an attenuator. Frequency range, impedance, attenuation, VSWR, accuracy and power rating are as designated above. Send for free bulletin entitled "Measurement of RF Attenuation."

STODDART aircraft radio co., inc.
6644-B SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA · HOLLYWOOD 4-9294

Industrial Notes

(*Continued from page 20A*)

was completely designed, assembled, wired, and tested at Belco's Paterson, N. J., plant, and shipped to Texas City by sea train.

NEW PRODUCTS

Distortion-Free, Regulated A-C Power. The Curtiss-Wright *EE100* distortion eliminating voltage regulator is a new instrument designed to eliminate disturbing harmonics and low-frequency noise in 115 v, 60 cycles-per-second power sources. It furnishes 1.4 kva of 1 per cent electronically voltage-regulated power with line distortion reduced to less than 0.3 per cent. The recovery time is almost instantaneous, being less than 1/50 cycle. There is no phase shift between input and output. Simultaneously, the instrument furnishes an additional 4 kva of 1 per cent electromechanically regulated power for those applications where normal line distortion and slower voltage regulation can be tolerated. The electromechanical time constant is only 0.6 seconds. For further information, write to Component and Instrument Department, Curtiss-Wright Corporation, Electronics Division, 631 Central Avenue, Carlstadt, N. J.

Oscillograph Offers Precise Measurement and Wide-Band Operation. High precision measurement and wide-band operation from direct-current to 20 mc are offered by a new Du Mont cathode-ray oscillograph, the type *329-A* which incorporates improvements while retaining features of the Du Mont type *329*, a predecessor instrument. Another version of the same instrument, designated type *323-A* is also available. This version is designed for those applications where a high accelerating potential is not required, such as the viewing and recording of repetitive phenomena. The type *329-A* has a frequency response from direct current to 3 db down at 10 mc with useful response to beyond 20 mc. The direct-coupled amplifier enables display of any signal without d-c slump. The instrument employs a type *5ATP* monoaccelerator cathode-ray tube which minimizes spot and field distortions. Sweeps of the type *329-A* are developed at high amplitude, eliminating the need for sweep amplification, thus removing a major source of sweep nonlinearity. By front-panel switching, an accurate voltage standard is applied to the screen. A simple adjustment calibrates the scale directly in volts for all attenuator settings. Two signals may be connected simultaneously to the dual input jack and each signal selected for viewing as the need arises. Once calibration is set, it holds for both input signals. Since isolation between inputs is greater than 50 db, unterminated, leaving either signal connected while measurements are made on the others will have

(*Continued on page 30A*)

How Much Does a Tower Cost?

The answer to this question is as indefinite as "How long is a piece of string?" But there are some facts that are often overlooked, and perhaps tower purchasers should ask that question. The cost of a tower is the summation of four important items, the use of any one of which without the others can be misleading.

1. COST OF TOWER DELIVERED TO YOU

Since 1911, American Bridge has operated a plant which specializes in electric transmission towers, substations and similar structures. Its modern equipment and facilities were designed specifically for that purpose, and savings accomplished assure you a quality product at the lowest possible cost.

2. COST OF FOUNDATIONS

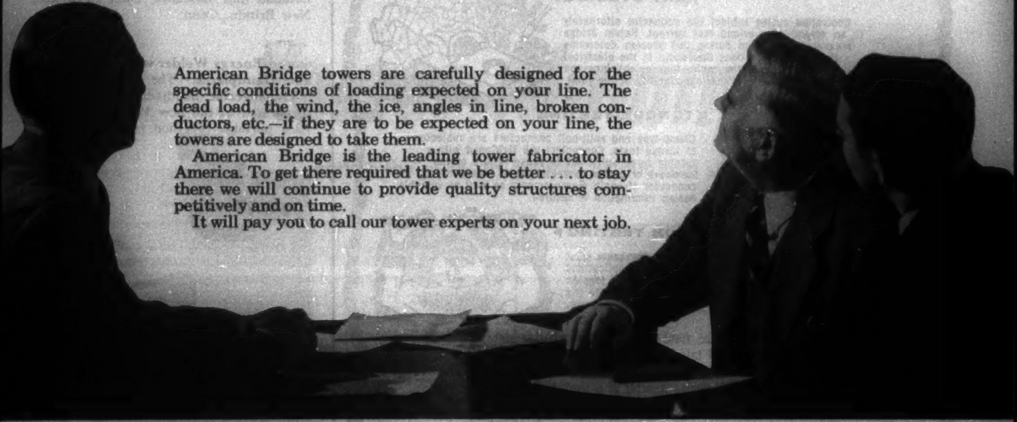
American Bridge strives to keep foundation costs low in its tower design. The rotated type tower, circular grillage and variable leg extensions are examples of how American Bridge works with its customers in a co-operative effort to reduce foundation costs.

3. COST OF TOWER ERECTION

The tower members furnished by American Bridge fit in the field. *Ask any tower erector to verify this fact.* Members are made alike on all four sides to facilitate erection. The same diameter bolts are used throughout the structure. These are sorted, packed and marked so that no time is lost looking for the right bolts for the connections; and the bolts themselves are the best obtainable. The nuts can be screwed on by hand preparatory to final tightening. Every member is stamped in the steel with its correct number to coincide with easily read erection drawings. *The fundamental reason for all this is to save you money.*

4. COST OF MAINTENANCE

All American Bridge towers are galvanized *after* fabrication by the hot-dip process. The resultant coating of pure zinc lasts for years.



American Bridge towers are carefully designed for the specific conditions of loading expected on your line. The dead load, the wind, the ice, angles in line, broken conductors, etc.—if they are to be expected on your line, the towers are designed to take them.

American Bridge is the leading tower fabricator in America. To get there required that we be better . . . to stay there we will continue to provide quality structures competitively and on time.

It will pay you to call our tower experts on your next job.

AMERICAN BRIDGE DIVISION, UNITED STATES STEEL CORPORATION • GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

ontracting Offices in: AMBRIDGE · ATLANTA · BALTIMORE · BIRMINGHAM · BOSTON · CHICAGO · CINCINNATI · CLEVELAND · DALLAS · DENVER · DETROIT · ELMIRA · GARY
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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

AMERICAN BRIDGE

USS

6-211

UNITED STATES STEEL

BURNDY connects... modern research techniques with product leadership

When a company's products are as important to almost every segment of American industry as BURNDY electrical connectors, those products have to be good. And because BURNDY connectors are only as good as their performance in actual operation, the BURNDY laboratories incorporate the very latest design and manufacturing research techniques to produce connectors that surpass requirements in every way.

The BURNDY laboratories use many scientifically accepted test techniques and quality control procedures during both product development and production random sampling.

◄ RELATIVE CONDUCTIVITY

Laboratory technicians use a Kelvin Bridge to measure to the nearest microhm electrical resistance across the connector joints, and compare readings with equal lengths of uninterrupted cable.

SALT SPRAY TESTS ►

Connector-joint stability is evaluated by submitting the sample joint to strict Federal Specification tests. A 20% solution of common salt in water at 100° F is atomized by means of air pressure, creating a highly corrosive vapor fog. After the required length of time, a Kelvin Bridge measurement is again taken. The findings prove invaluable in creating corrosion-resistant connector designs.

◄ VIBRATION CYCLING

Many Burndy connectors are designed for rotating machinery and in trains, cars and aircraft. BURNDY carefully tests the prolonged effects of vibration. Kelvin Bridge measurements determine vibration stability, and determine any tendency toward fatigue failure.

HEAT CYCLING ►

Controlled cycles subject the connector alternately to an on-and-off overload test current. Kelvin Bridge measurements taken during this process determine the temperature rises that occur in the electrical joint and in the cable, thus establishing the electrical stability of the joint.

◄ TORQUE TESTING

Clamp-type and split-bolt connectors are subjected to torque tests. Connectors are tightened with a turning force sufficient to cause failure of the hardware or of the connector itself. Maximum connector strength measurements as well as valuable design information is secured.

TENSION TESTING ►

Where full tension is required, the cable must break before the connector fails. Most applications do not require this extreme, and tension requirements are established according to the connector's final use.

BURNDY specializes in only one field—that of making better electrical connectors. BURNDY's special talents are available to all industry. Whatever your electrical connector need, BURNDY has the experience and the facilities to serve you. That is why for over a quarter of a century BURNDY has been the leader in its field.

For further information, or assistance on your particular problem, write to . . .

BURNDY
16-3
NORWALK, CONNECT.

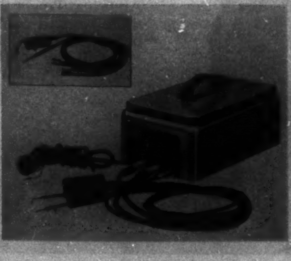
New Products

(*Continued from page 28A*)

negligible effect on measurement. Complete electrical and physical specifications on the Du Mont type *329-A* may be obtained from the Technical Products Division of Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Avenue, Clifton, N. J.

12-Position Rotary Switch. A new line of low-current, subminiature rotary switches 1.160 inches in diameter, including contacts, that offers 12 stator positions per deck exclusive of poles has been announced by International Instruments Inc., New Haven, Conn. Designated the series *7,000*, these switches are designed for use on electric and electronic testing equipment, miniaturized and transistorized devices, and other applications when saving space is important. The *7,000* series switches provide great versatility in this small size. Standard contact arrangements from 1 pole of 12 positions to 4 poles of 3 positions are offered; all have positive indexing with $1^1/_2$ inch-pound torque. One, two, or three decks can be supplied with continuous rotation with single pole or stops for multipole operation. Featured is a wafer of a specially impregnated glass melamine which has high humidity resistance and is very tough, but not brittle. Wafer contacts are silver plated and double wiping for low contact resistance, and self-cleaning for long life. Another feature is the inclusion of solder type lugs on the wafer's connection ends for ease in wiring. Single piece rotor-contact construction minimizes resistance and chance for failure from corrosion, etc. For further information contact Robert D. Hall, Hugh H. Graham and Associates, Inc., 10 Arcade, New Britain, Conn.

Stored-Energy Welder with Interchangeable Handpieces. The versatility of two interchangeable handpieces has been incorporated in the new Weldmatic model *1016* portable precision resistance welder manufactured by the Unitek Corporation, 275 North Halstead Avenue, Pasadena, Calif. Besides offering flexibility in all small electronic assembly applications, the Weldmatic model *1016* which is complete in itself, speeds and simplifies installation



(*Continued on page 36A*)

URGENT BUDGET QUESTIONS

for utility management men!

Q. Now—particularly in the face of continually increasing copper prices—is your utility giving immediate and urgent attention to making a complete conversion to aluminum?

Even before the recent copper price increase, major utilities all over the country have saved thousands of dollars a year by changing to Kaiser Aluminum conductors. The latest copper increase means they will now save even more! (See box below, right.)

Q. Have you discussed with your key personnel the great and growing price advantage of Kaiser Aluminum over copper?

Do they completely understand that the price spread between aluminum and copper is *continually widening* . . . that this spread is likely to *widen further* in the forseeable future? (See box below, left.)

Q. Is your utility fully aware of the complete services available to them to make conversion easy?

To help utilities take full advantage of the big savings offered by aluminum over copper, Kaiser Aluminum is ready to provide immediate technical assistance and field engineering service.

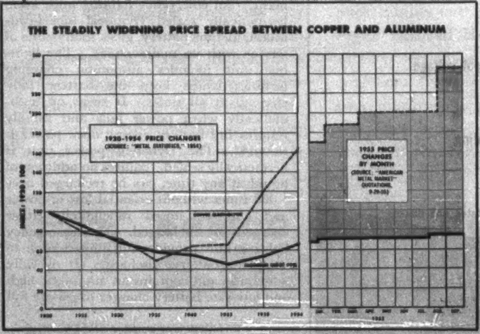
Q. Does your utility have the latest information on the rapidly changing aluminum connector situation?

We can put your utility in touch with manufacturers of recently improved copper-to-aluminum connectors that are giving satisfaction to utilities all over the country.

For complete cooperation, call or write Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office*, Palmolive Building, Chicago 11, Illinois. *Executive Office*, Kaiser Building, Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

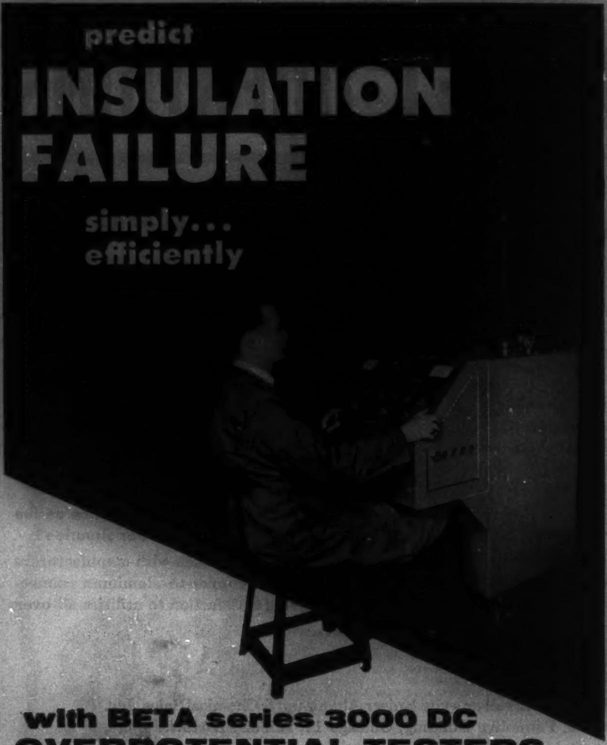


THE STEADILY WIDENING PRICE SPREAD BETWEEN COPPER AND ALUMINUM

Estimate your savings with these Kaiser Aluminum weatherproof conductors:

	Per 1000 Ft. Lbs.	Per 1000 Ft. Cost
#6-1 Copper TBWP*	112	$ 57.77
#4-1 Alum PE (2/64)	48	28.50
#4-1 Alum Neo (3/64)	64	28.50
#2-7 Copper TBWP*	270	139.40
1/0-7 Alum PE (4/64)	141	74.00
1/0-7 Alum Neo (4/64)	172	74.00
2/0-7 Copper TBWP*	522	258.55
4/0-7 Alum PE (4/64)	261	145.00
4/0-7 Alum Neo (4/64)	306	145.00
4/0-7 Copper TBWP*	800	394.64
336.4-19 Alum PE (4/64)	388	231.00
336.4-19 Alum Neo (4/64)	469	231.00

Sept. 29, 1955 prices based on 30,000# — F.O.B. Destination
***URC Copper Triple Braid Weatherproof**



predict

INSULATION FAILURE

simply... efficiently

with BETA series 3000 DC OVERPOTENTIAL TESTERS

Ideal for either acceptance or in-service field testing of cables, insulators, generators, dynamos and other large rotating equipment; even transformers and bushings... the BETA Series 3000.

The use of DC eliminates capacitance currents and permits a gigantic reduction in size and weight, making test equipment both mobile and portable. Direct leakage current measurement permits positive checking of quality and life expectancy at test voltages that are non-destructive and non-deteriorating.

Built-in safety features such as interlocks and overload relays protect operators. Unmatched dependability is assured . . . with the BETA Series 3000.

SPECIFICATIONS

- INPUT VOLTAGE — 105-125 v., 50/60 cycle, or to order
- INPUT CURRENT — 2x rated maximum output current
- OUTPUT VOLTAGE — 0-15 to 0-250 kv, continuously variable
- OUTPUT CURRENT — 2 to 10 ma, continuously available at rated output voltage
- POLARITY — Negative, positive or reversible, to order
- RIPPLE — 0.3% rms at no load
- INSULATION — air (0-30 kv), oil above 30 kv
- LINE VOLTAGE STABILIZATION — ±1% for ±15% variation from rating

Write TODAY for technical data on DC Overpotential Testing Techniques and the complete line of BETA AC and DC "Hipot" Testers and Power Supplies.

BETA field engineers are available for consultation throughout the United States and Canada

Beta Electric Corp.
333 East 103rd St. N.Y. 29, N.Y.

(*Continued from page 30A*)

of high-temperature strain gauges. The model *1016* joins dissimilar metals and parts of varying thicknesses easily, firmly, and instantly. In strain gauge work, the long-lead handpiece of the model *1016* welds the gauge rigidly to the test piece, entirely from the side of the work, if necessary. Welds may be subjected to any temperature or other conditions which the gauge itself will withstand. After welding, the gauge may be placed in use immediately. Applications of the new Weldmatic product extends to moderate as well as high temperature strain gauge work. The welder will also accommodate the entire range of metal-foil-backed strain gauges now being developed for welding directly to steels, super alloys, aluminum and other materials. In welding stainless steel resistance alloys, etc., the model *1016* handles sheets from 0.0005 to 0.015 inch thick and wire ranging in diameter from 0.0001 to 0.045 inch. In copper alloys, aluminum, etc., it welds sheets from 0.0003 to 0.0008 inch thick and wire in diameters of 0.0001 to 0.020 inch.

Weston Speed-Change Sensing System. Designed for use in precision automatic speed control equipment, a new speed-change sensing system, which provides high accuracy, flexibility, maintenance-free operation, and low initial cost, has been announced by the Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark, N. J. This new unit, which makes use of the Weston Frequency Responsive system, will react to a speed change as small as 1/4 of 1 per cent of its top operating speed, and can be used at any speed up to 80,000 rpm. The circuit is very simple, and no vacuum tubes are used. While completely automatic in operation the unit also incorporates a Tachometer indicator to provide the operator with continuous speed indication. Complete information on this new speed-change sensing system, including installation data, can be secured from the manufacturer.

Lifetime Emergency Lighting Equipment. An emergency lighting unit, using hermetically sealed Dynaseal nickel-cadmium, lifetime battery, gives many years of service with no maintenance. The lighting unit includes automatic charging facilities which keep the battery fully charged at all times. It turns on automatically when power fails and rapidly restores full battery energy once power is resumed. The Dynaseal power unit is hermetically sealed, requires no addition of liquid at any time, can be recharged over 1,000 times without essential loss of power and can be stored indefinitely either charged or discharged. The emergency lighting unit provides full illumination to complete battery discharge. It is fully automatic and contains an automatic high and low rate battery charger to restore full

(*Continued on page 38A*)

ARMCO
ORIENTED
ELECTRICAL
STEELS

New Oriented Silicon Steels for LIGHTER-WEIGHT Transformers

Armco Oriented Electrical Steels have spearheaded revolutionary changes in transformer design for the last 15 years because of these principal advantages:

Lower Core Loss

These electrical steels give the designer silicon steels with much lower core loss in the rolling direction than any conventional cold-reduced or hot-rolled grades.

Higher Permeability

The Armco oriented grades have another unique advantage over conventional electrical steels—higher permeability at high inductions combined with lower core loss. Before the introduction of oriented silicon steel, lowered core loss was obtained only at the expense of permeability at high transformer inductions. As core loss improved, the exciting current became the limiting factor in design. The oriented grades overcame this handicap.

Other Advantages

In addition to lower core loss and higher permeability in the rolling direction, Armco Oriented Electrical Steels have excellent lamination factors and surface insulations. They are supplied with magnetic properties fully developed at the mill. Only a low-temperature (1475 F) anneal is required for stress-relieving.

New Information Available

Original grades of Armco Oriented Electrical Steel are long obsolete, replaced by lower core loss grades. Magnetic data now available are more complete.

Write us on your company letterhead for a copy of "Armco Oriented Electrical Steels—Third Edition, July, 1955." This 56-page catalog gives extensive information on the present Armco Oriented grades, M-6W, M-7W, M-6X and M-7X.

ARMCO STEEL CORPORATION 1515 CURTIS ST., MIDDLETOWN, OHIO

SPECIAL STEELS

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

UHF

ULTRA HIGH FREQUENCIES

radio
interference
and
field
intensity*

MEASURING EQUIPMENT

Stoddart RI-FI* meters cover the frequency range 14kc to 1000 mc

VLF

NM-10A, 14kc to 250kc

Commercial Equivalent of AN/URM-6B.
Very low frequencies.

HF

NM-20B, 150kc to 25mc

Commercial Equivalent of AN/PRM-1A.
Self-contained batteries. A.C. supply optional. Includes standard broadcast band, radio range, WWV, and communications frequencies
Has BFO.

VHF

NM-30A, 20mc to 400mc

Commercial Equivalent of AN/URM-47
Frequency range includes FM and TV bands.

Stoddart NM-50A
375mc to 1000mc
Commercial Equivalent of AN/URM-17

ULTRA-HIGH FREQUENCY OPERATION . . . Frequencies covered include UHF and color television assignments and Citizen's Band. Used by TV transmitter engineers for plotting antenna patterns, adjusting transmitters and measuring spurious radiation.

RECEIVING APPLICATIONS . . . Excellent for measuring local oscillator radiation, interference location, field intensity measurements for fringe reception conditions and antenna adjustment and design.

SLIDE-BACK CIRCUIT . . . This circuit enables the meter to measure the effect of the peak value of an interfering pulse, taking into account the shaping due to bandwidth.

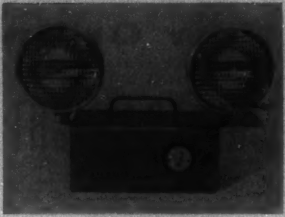
QUASI-PEAK FUNCTION . . . An aid in measuring pulse-type interference, the Quasi-Peak function is just one of the many features of this specially designed, rugged unit, representing the ultimate in UHF radio interference-field intensity equipment.

ACCURATE CALIBRATION . . . Competent engineers "hand calibrate" each NM-50A unit. This data is presented in simplified chart form for easy reference.

SENSITIVITY . . . Published sensitivity figures are based on the use of the NM-50A with a simple dipole antenna or RF probe. However, the sensitivity of this fine instrument is limited only by the antenna used. The sensitivity of the NM-50A is better than ten microvolts across the 50 ohm input.

STODDART aircraft radio co., inc.
6644-B SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA · HOLLYWOOD 4-9294

(*Continued from page 36A*)



charge in the battery once the emergency lights are used. Its dimensions are 17 inches long by 7 inches wide by 11¹/₂ inches high and weighs 13.5 pounds. For full information write for bulletin *A46* describing the Dynaseal power bloc, and bulletin *A71* describing Dynaseal lifetime emergency lighting units, to Dynaseal Lighting Corporation, 5 Hadley Street, Cambridge, Mass.

Electrolytic Capacitors. A new series of electrolytic capacitors meeting the rigid reliability requirements of telephone systems have been made applicable to electronic equipment in other fields by the Sprague Electric Company, 321 Marshall Street, North Adams, Mass. Turret-terminal and mounting lugs, and a special vent construction are molded right into the cover of the type *17D* capacitors as are the numbers which identify each terminal. The seal, made by crimping the aluminum can onto a gasket, has proved dependable. The cans are covered with a corrosion-resisting insulation coating. There are available 19 standard ratings in the series covering a wide range of applications in single, dual, and triple section units. All are characterized by low maximum leakage current and life test capabilities. Complete technical data is provided in Engineering Bulletin *340*, available on letterhead request to Sprague's Technical Literature Section.

Cathode-Ray Oscilloscope. The Southwestern Industrial Electronics Company's new model *MO 24* trace cathode-ray oscilloscope presents multichannel information on a 21-inch picture tube for direct viewing. Information is presented by intensity modulation of a 5,000-cycle-per-second raster. The raster method results in frequency response useful to 500 cycles per second on all 24 traces with only a single electron gun. Each trace may cross over traces, and is limited in amplitude only by the size of the cathode-ray tube. A position control is provided for each trace. A special "window" control permits a portion of the sweep to be accelerated for careful examination. An auxiliary unit, the Event Pre-Selector, puts 0.1 and 0.01 second timing lines over the scope, and triggers the sweep after an adjustable delay period following the initial pulse. This feature is useful when the *MO 24* is used as a monitor

(*Continued on page 40A*)

BROWN BOVERI

AIR BLAST BREAKERS

One pole of

330 kv 25,000,000 kva

BROWN BOVERI AIR BLAST BREAKER

for installation in the United States,
set up for special impulse coordination tests.

BROWN BOVERI

BROWN BOVERI CORPORATION
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Brings between the covers of a single volume materials data from dozens of special fields. Broader in scope than any other book, it provides a source of reliable information on materials of manufacturing and construction in every field of engineering, and covers all the main factors in the selection of materials. Contains a wealth of valuable references, too.

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New Products

(*Continued from page 38A*)

for 24-channel magnetic tape recordings, such as those used in seismograph work. Southwestern Industrial Electronics Company is located at 2831 Post Oak Road, Houston, Tex.

Wire-Wound Resistors. A complete line of vitreous enameled wire-wound resistors, ranging from 2 watts to 2,000 watts inclusive, is now being manufactured. In addition to the standard lines of fixed or adjustable resistors, there are oval, ribwound and ferrule types available. The resistors are wound with a high-grade resistance wire on specially designed steatite cores and are then covered with two coats of vitreous enamel. All electrical connections are silver soldered. A tolerance of ± 10 per cent is considered standard. However, a closer tolerance can be maintained. For details write to L. A. Resistor Company, Inc., 14742 Arminta St., Van Nuys, Calif.

Console Indicator for RAFAX System. The Haller, Raymond and Brown, Inc., State College, Pa. RAFAX system permits the transmission of plan position indicator type radar information over audio circuits such as telephone lines or radio links. After transmission over such a circuit, the signals are used to recreate a facsimile of the original radar picture. Bandwidth compression is accomplished by means of an optical-electronic scanning device which is capable of giving compression ratios of 100 or greater. The compression ratio achieved is a direct function of the scanning rate. The RAFAX system consists of an encoder that receives radar, video, and antenna rotation information, and after bandwidth compression, places this information on two carriers; a decoder that separates the two subcarriers and extracts the modulation information; and an indicator which accepts either the decoder output or normal radar signals. Since RAFAX signals are of audio bandwidth, they may be recorded on standard magnetic tape. Two-channel recorders can then record radar situation and voice radio traffic simultaneously on a single tape.

One-Millimeter Pinhole Detector. A redesigned pinhole detector for strip steel

(*Continued on page 43A*)

New Products

(*Continued from page 40A*)

with a sensitivity five times greater than the former model has been announced by General Electric. Under actual operating conditions on cold rolled strip steel, the new model will detect holes down to 1 mm diameter in opaque strip measuring 10 mm or less in thickness. The new model functions with maximum sensitivity at strip speeds up to 2,000 feet per minute. Laboratory tests indicate a potential in excess of 6,000 feet per minute. The redesigned detector will scan a strip up to 48 inches wide, compared with the 40-inch capacity of the former scanner. A significant feature of the new design is a more than tenfold increase in the light source, made possible by replacing an array of 21 small projection lamps with a single mercury-vapor lamp. Comparative figures are a 2,000 foot-candle output with the array of projection lamps and more than 25,000 foot candles with the new single light source.

New Cable Tap Cuts Installation Time. A unique device for making permanent weatherproof cable taps without severing the cable or stripping leads has been developed by the Jerrold Electronics Corporation, 23d and Chestnut Streets, Philadelphia, Pa. Developed to connect individual service drops to the main feeder cables used in community television antenna systems, the new pressure tap likewise presents interesting possibilities as a low cost tap for utility, telephone, and control system cables. Either coaxial, or single-conductor solid or stranded cables may be used with the tap. When coaxial cable is used, connection is automatically made to the center conductor as well as to all outer conductors. Shunt capacitance is held to less than 1.5 micromicrofarads. The pressure tap reduces the time "on the ladder" required to make a permanent cable connection. One bolt securely clamps both the pressure tap and the feeder cable to the messenger wire. A special cutting tool is then screwed into the tap to pierce the outer jackets, and after the cutting tool is removed, the service-drop connector is screwed into the tap forming a positive, low-loss connection between the feeder cable conductor and the service drop. The service-drop messenger hook and connector permit servicing, testing, or disconnecting the service drop without dis-

(*Continued on page 44A*)

Let's take a look at the record—first

In specifying capacitors may we suggest you do just that . . . Take a look at the Record.

Here is proof-positive you should have before making commitments to purchase capacitors.

Reproduced on the right is an actual life test record of a group on test since August 3, 1947, a period of over 8 years.

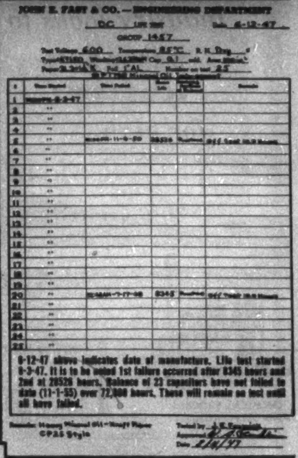
This represents only one of thousands of such tests made for more than 20 years—not occasionally—but year in and year out, twenty-four hours of every day.

While it is hardly necessary to remind you this is an expensive procedure—you cannot build *reliability* into a capacitor by specifications alone or be assured of it by ordinary accelerated life tests. (Terminated after 250 hours, for example.)

Reliability can only be established through designs based on the knowledge acquired from many long time tests of large group sizes such as we carry on—these are the only alternative. Cost in this respect is secondary as recovery of this added expense comes through less failures in the field.

When you have a capacitor requirement . . . Take a look at the Record . . . *first.* Specify FAST—The only capacitor with a "Proven Pedigree."

We are presently the only capacitor manufacturer qualified under the Signal Corps Reduced Inspection Quality Assurance Program. (RIQAP)



JOHN E. FAST & CO. — ENGINEERING DEPARTMENT

DC LIFE TEST Date 6-12-47

GROUP 1457

6-12-47 above indicates date of manufacture. Life test started 8-3-47. It is to be noted 1st failure occurred after 8345 hours and 2nd at 28526 hours. Balance of 23 capacitors have not failed to date (11-1-55) over 72,000 hours. These will remain on test until all have failed.

CP25 Style

JOHN E. FAST & CO.

Capacitor Specialists For
Over A Third of A Century

3169 North Pulaski Road, Chicago 41, Ill.

"WHEN YOU THINK OF CAPACITORS . . . THINK FAST"

AVAILABLE LITERATURE:
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NON-LINEAR SYSTEMS new digital voltmeter--Model 451.

DIGITAL VOLTMETER

write for bulletin 241

Special design
for industrial applications.

Uses oil-immersed stepping switches,
life-tested for 20,000,000 readings.

Measures from
±0.001 to ±999.9 volts d-c.

Automatic
decimal point location and polarity
indication in luminous display.

Rapid and accurate measurement
by non-technical personnel.

NON-LINEAR SYSTEMS, INC.
Del Mar Airport
Del Mar, California

Industry looks to
RESEARCH-COTTRELL
for high dust collection efficiencies

To maintain visually clean stacks at all times, industry is turning to the long experience of Research-Cottrell in the design and manufacture of highly efficient Cottrell Electrical Precipitators. We've spent 40 years in solving such problems as nuisance abatement, cleaning gas for subsequent use and recovering materials of value. Write for illustrated bulletin describing a wide range of electrical precipitator applications.

CHEMICAL PROCESS AND STEEL INDUSTRY
POWER PLANTS
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FOUR-CHANNEL CARRIER-TELEPHONE TERMINAL FOR RADIO LINKS

This is a miniaturized unit of advanced design which provides four voice channels on a frequency-division basis above a voice-frequency order-wire channel. Each of these five channels is provided with a 4-wire 2-wire termination and a voice-frequency ringing circuit for d-c or 20-cycle signals. Adjustable attenuators are provided in the 4-wire side of all channels, and a built-in test oscillator and meter permit complete line-up, maintenance and trouble-shooting checks to be made. Channel levels are from −9 to 0 dbm and line levels from −30 to 0 dbm. Channel width is 300 to 3500 cycles within 1 db.

This unit is only 5¼″ high by 19″ wide by 14″ deep. It mounts on a standard rack and operates from 115 volts 50-60 cycles a.c.

RADIO ENGINEERING PRODUCTS
1080 UNIVERSITY ST., MONTREAL 3, CANADA
TELEPHONE UNiversity 6-6887
CABLES RADENPRO, MONTREAL

New Products

(*Continued from page 43A*)

turbing the pressure tap or its weatherseal. Details of applications will be supplied by Jerrold to the utility, telephone, and other industrial fields upon request.

Custom Cable Machine. A new planetary cabler, designed and built by Douglas Roesch, Inc., offers a solution to the problem of supplying "custom" electronic cable in prototype or production runs. The new machine has fabricated intricate cables from fragile strands of conductors, delicate coaxial circuits, precision balanced quads, and power leads into one manageable cable length. Quality can be compared favorably to mill-run, "catalogue" power cable, despite the fact that most Roesch cable fabrications are highly specialized short-run components. Descriptive brochure and samples are available from Douglas Roesch, Inc., Cable Division, 2200 South Figueroa Street, Los Angeles, Calif.

Milatomic Filter. Atomic Instrument Company, Cambridge, Mass., has announced it will handle distribution of the Milatomic filter to the atomic energy field. The filter is for use in collection and assay of radioactive precipitates. The Milatomic filter has a high degree of retention, and is capable of separating quantitatively extremely fine particles on the order of 1.20 microns from liquid vehicles. This material filters microscopic and submicroscopic particles as a surface phenomenon or screening action, in which retention is defined by pores of controlled dimensions. There are 35 million pores, nearly molecular in size, to the square centimeter. The filter material is 85 to 87 per cent porous and is used in studies of the effects of radiation. For full information write Atomic Instrument Company, 84 Massachusetts Avenue, Cambridge, Mass.

Pilots Guide Nuts onto Thread. Clamp-top insulators, either pintype or line post, from Ohio Brass Company are now available with the bolts illustrated. Smaller diameter, unthreaded stock at the bolt end acts as a pilot to guide a nut onto the threads without hesitation or delay.

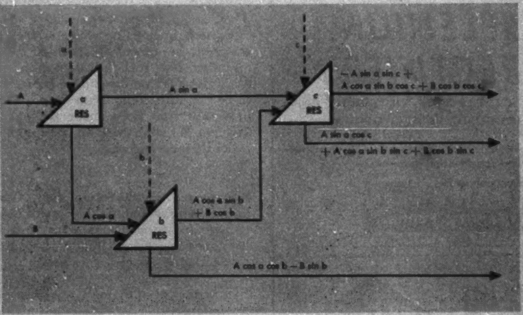
(*Continued on page 46A*)

FORD INSTRUMENT
solved one design problem by
CASCADING RESOLVERS
WITHOUT
ISOLATION AMPLIFIERS

To get around a problem that arises in almost every resolver application Ford engineers recently designed a computer which, among other things, employed a chain of cascaded resolvers to solve complex trigonometric equations, without the use of isolation amplifiers. They solved such an equation as:

$$A \sin a \cos c + A \cos a \sin b \sin c + B \cos b \sin c$$

This was successfully done, without use of vacuum tubes or amplifiers in this circuit:



In view of the widespread use of resolvers to generate sine and cosine functions in modern electro-mechanical analogue computers, it is of great practical significance. Resolvers produced by the Ford Instrument Company have now reached such a high degree of precision, that it is possible to obtain, from an unloaded resolver (which accommodates a single angular quantity only), an accuracy to within less than one tenth of one percent. But most computing circuits call for the use of several resolvers, and once an ordinary resolver is loaded by another resolver, no matter how high its precision, the overall accuracy of the resolver cascade is seriously affected.

The conventional method of avoiding this difficulty is to use an isolation amplifier for each resolver, so that the resolver continues to operate under no-load conditions regardless of the size of the cascade. The importance of cascading without amplifiers is readily appreciated if we realize that the isolation amplifier usually increases the cost of the equipment, more than doubles the size and generates many times more heat that must be dissipated to prevent breakdown of the components. Furthermore, the use of vacuum-tube amplifiers always raises the problem of tube ruggedness and reliability, and requires an additional source of d-c plate voltage.

Have you problems which the engineers at Ford might solve by designing and manufacturing computers, controls or their elements? Write for further information.

85

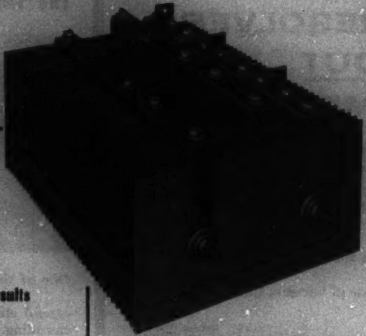
FORD INSTRUMENT COMPANY
Division of Sperry Rand Corporation
31-10 Thomson Ave., Long Island City 1, N. Y.

Ford's capabilities are among the finest in the country

One of the Ford laboratories where a particular design project has called for careful study of resolvers and resolver cascading. Two of the engineers assigned to this project are here checking results. From this work will come one of the new, highly classified weapon systems for the armed forces.

For accuracy and reliability—both vitally necessary in military instruments—experienced machinists must work to fine precision—in the order of .0005 of an inch. Here in one section of the shops of Ford Instrument Company, men are milling parts for an airborne computer.

During the past year Ford Instrument Company has been busy working on many contracts for the U. S. Air Force and the U. S. Navy Bureau of Aeronautics, designing and manufacturing complex computers, controls and their components. For over forty years, Ford Instrument Company has devoted most of its efforts in working for the government to the many problems of weapon controls.



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SYNTRON

- Vacuum Process Insures Uniform, High Quality
- Lowest Forward Voltage Drop Means Greater Efficiency
- Extremely Slow Ageing Results In Extended Life
- Greatest Range of Cell Sizes In The Industry—From 1" Square to 12" x 16" Plates
- Installation In Actual Operation Range Up To 600 KW

SELENIUM RECTIFIERS

Approved salt spray and fungus resistant finishes available

Write today for complete performance and specification data—Free

SYNTRON COMPANY
446 Lexington Avenue Homer City, Penna.

Another Substation by FLINT STEEL

Steel Specialist for the Electrical Industry

The substation shown is just one more example of the completely integrated and personalized service of Flint Steel. Whether the job is large or small, we specialize in *your* requirements . . . from consultation to erection. When you build anything with galvanized structural steel — anywhere — consult us.

FLINT STEEL
TULSA
MEMPHIS
Sold Competitively Everywhere

(Continued from page 44A)

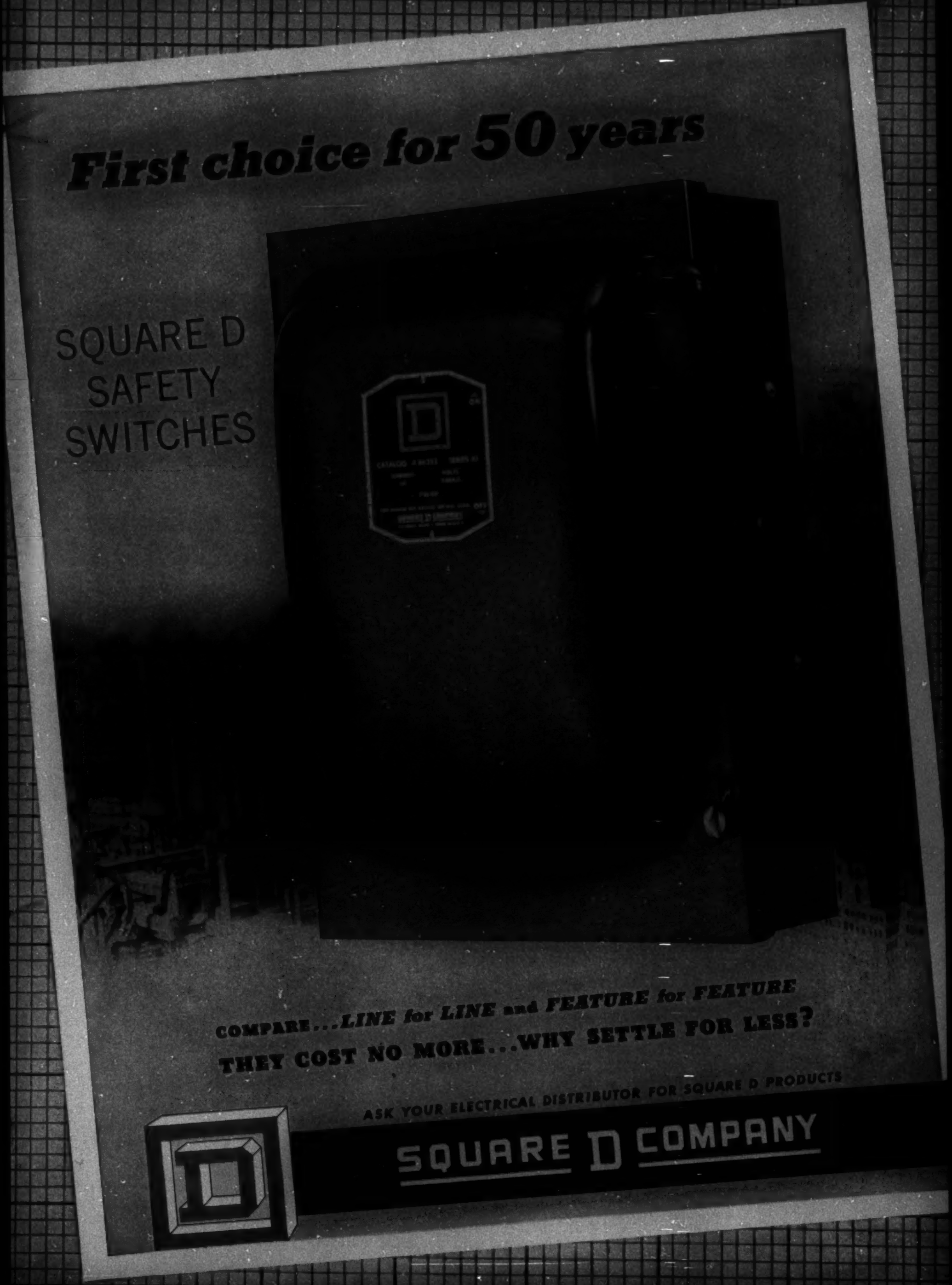
These relieved ends provide a distinct advantage in hot line work, as they align the nut in threading position without excessive hot stick manipulation. Bolts of this type are now available for use on all three Ohio Brass clamptop sizes. The improvement has been made to make the frequent hot stick work on clamptops even easier than heretofore.

Pressurized Connector for Guided Missile Applications. The series *GA*, 40-contact pressurized connector has been developed primarily for guided missile applications. A center screwlock, with spring action, permits rapid engaging and disengaging of the new connector while preventing damage often encountered when prying apart or forcing separation of plug and receptacle. Individually, spring-loaded contacts also assure easy release of the connector at all times. The plug is molded from Orlon filled diallyl phthalate. Pin contacts are precision-machined from nickel silver and gold-plated only 0.0001 inch thick. The hood, cable clamp, and all hardware are made from stainless steel. Complete technical information, specifications, and diagrams are available on request. Write for bulletin *GA* to: Electronic Sales Division, DeJUR-Amsco Corp., 45-01 Northern Boulevard, Long Island City, N. Y.

Streamlined Staticator. The Hewson Company, Inc., has announced a new and streamlined Staticator (registered trademark) designed for use in hospital operating rooms. This new unit provides both audible and visual warnings whenever static electricity is present anywhere in the operating room. The new hospital Staticator comes as a complete package unit that includes all equipment and accessories necessary to protect any size hospital operating room against unsuspected static hazards. Everything necessary for installation is included in the complete package unit. For full information, write The Hewson Company, Inc., 443 Broad Street, Newark 2, N. J.

(Continued on page 48A)

Vol. 7
1956



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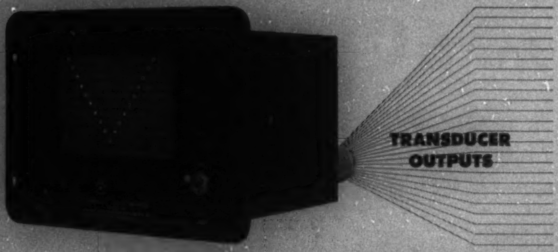

Century MODEL 20 VISUAL MONITOR

For TEMPERATURE PRESSURE VIBRATION FLOW RADIATION COLORIMETRY CURRENT VOLTAGE

Does your data problem include any of the above? Or anything similar?

The Model 20 Visual Monitor is a completely new concept in multiple data-point indication.

Now you can observe and measure 24 separate data points, simultaneously. No Switching, no commutating, no time lag.

Wherever a graphic display of several quantities will facilitate measurement and control, the Model 20 should be considered.

Utilizing light-beam D'Arsonval galvanometers as the indicating elements, the Visual Monitor permits display of transducer output in an easy-to-interpret, graphic form.

Let us hear from you. We would like to discuss your instrumentation problems with you.

Century Electronics & Instruments, Inc.
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A complete line of dry type and liquid-filled transformers through 5000 KVA.

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New Products

(*Continued from page 46A*)

Two-Hand Clutch Control. A new, improved electric two-hand clutch control for industrial machines that increases both production and operator safety has been developed by Micro Switch of Freeport, Ill., a division of Minneapolis-Honeywell Regulator Company. Use of the system, known as Micro Switch trip control, can increase productivity of manually operated power machines by as much as 20 per cent.

The increase is made possible by simple, direct operating motions of the operator; feather-touch, finger-tip operation of the control switches; and other features which reduce operator fatigue and speed up the machine's operations. With worry over their personal safety eliminated, operators of the control system develop a smooth, time-saving load-trip-and-unload sequence. Down-time also is reduced, with fast, easy control changes and no adjustments required from die to die. The "fail safe" feature makes accidental operation of the clutch impossible. The clutch can operate only when the control system is functioning properly. Two sets of contacts close on the actuator load on each operation, and both must be released before the next operation can be performed. A third set of contacts "breaks" the load, eliminating any danger of sticking contacts. The system's "can't cheat" feature requires operation of all the switches in the control circuit within a predetermined and adjustable time interval. Both hands must be on the controls and, thus, cannot be extended into the danger area. Illustrated is a complete Micro Switch Trip Control packaged set, including hand switches, limit switch, and control box, for use with light mechanical clutch machines, air presses, etc.

All-Purpose Relays. The Ohmite Amrecon models DO and DOS relays have been announced by the Ohmite Manufacturing Company, 3681 Howard Street, Skokie, Ill. The Ohmite Amredon models DO and DOS relays are general purpose relays with a wide range of applications. Designed to meet the rigorous standards for aircraft and mobile equipment applications, the two models meet industrial needs for a compact, lightweight relay capable of handling power loads usually demanded

(*Continued on page 50A*)

NOW . . . a powerful electric STARTER FOR MIDGET TURBOJETS

Starting a lightweight turbojet engine, such as the 1000-pound thrust Fairchild J44, is never a problem with the rugged Model D62 starter developed by Jack & Heintz. This starter is an electric, direct cranking unit which has substantially bettered the starting time limitations established by the engine manufacturer.

Field Proven

The D62 starter is establishing an enviable operational record on the small J44 turbojet engines being used as wing-tip thrust assist power plants on Fairchild's C-123B Assault Transport. Modifications of the D62 are in use on other specialized applications including Solar's gas turbine driven a-c power pod installations on the Convair C-131B. In addition, a new higher speed starter extremely light in weight for small turboprop engines has been developed and is being engine tested.

Special Features

Features of the J&H Model D62 include: grounded, irreversible, series-wound, interpole-type motor; planetary reduction gearing with multiple disc torque limiter; and an automatic jaw meshing mechanism, providing quick-acting positive engagement.

This small power package or a modification of it engineered to your particular application may be the answer to your starting problem. Send for complete data including performance curves and dimensional drawings. Write Jack & Heintz, Inc., 17622 Broadway, Cleveland 1, Ohio. Export Dept.: 13 E. 40th St., New York 16, N.Y.

CHARACTERISTICS

Engine Mounting Pad	AND20002, Type XII-S (except opposite rotation)
Starter Input:	
Voltage, d-c	22-28
Current, amp (max)	450
Starter Output	30 lb-ft @800 rpm, 24 v
Gear Reduction	7:1
Torque Limiter:	
Breakaway Torque, lb-ft (max)	80
Slipping Torque, lb-ft (max)	65
Slipping Torque, lb-ft (min)	55
Jaw Teeth, number	3
Rotation, viewed from anti-drive end	Counterclockwise
Weight, lb (approx net)	25

OPPORTUNITIES FOR ENGINEERS

There's a promising future for electrical and mechanical engineers at Jack & Heintz. Write Manager of Technical and Professional Placement, today, for illustrated, descriptive booklet.

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JACK & HEINTZ *Rotomotive* AIRCRAFT EQUIPMENT

New Products

(Continued from page 48A)

of much larger and heavier relays where severe shocks and vibrations are encountered. The insulation is of high grade molded phenolic material around the moving contact arms affording maximum protection. Contact rating is 10 and 15 amperes respectively at 115 volts a-c or 32 volts d-c noninductive load. The relay is available from stock in a wide range of coil operating voltages for either alternating-current or direct-current. Write for catalogue *R-26* for additional information.

TRADE LITERATURE

Microwave Manual. A new 226-page service manual on wave propagation and other aspects of very-high frequency and microwave radio relay systems has been published by the Government Service Department of the RCA Service Company, Inc., for the benefit of electronics engineers, technicians and students. Entitled "Point-to-Point Radio Relay Systems—44 MC to 13,000 MC," the manual was published originally under contract for the United States Air Force, which now has approved reprinting the commercial sale. Copies are available from the Government Service Department, RCA Service Company, Inc., Camden, N. J., at $2 each, postpaid, or for training purposes in quantities of 10 or more, at $1.80 each, postpaid.

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Holophane Datalog. The new 64-page Holophane Datalog is a reference guide for commercial, institutional, industrial, and outdoor lighting. Fundamentals of light control, recommendations for illumination levels, lighting design data, installation procedure, special applications, and spacing are included in this publication. A comprehensive index makes it possible to locate any unit or accessory quickly.

Berylco Product Directory. New extrusion items are offered in the revised edition of Berylco Product Directory now available from The Beryllium Corporation, Reading, Pa. In addition to both extruded rod and bar stock, the directory announces the availability of seamless beryllium copper tubing in redraw sizes and extruded shapes. Copies of the directory may be obtained by writing to the manufacturer.

Ohio Brass Book. Through the publication, Hi-Tension News, Ohio Brass Company offers interested power utility people a copy of their 130-page book, Lightning Performance of Typical Transmission Lines. This book reports the lightning experience of 68 power companies operating 119 different lines. Reports of foreign transmission lines are included. Each line covered in this book is illustrated with a photograph, and a line drawing with principle dimensions, of the typical structure. Persons requesting copies are asked to explain their interest in the book, to help Ohio Brass Company in preparation of similar material in the future.

Vibration Measurement. A new publication, "Measurement of Vibration," has been made available by the General Radio Company. This 64-page booklet covers the meaning of vibration terms, description of vibration-measuring instruments, procedures, typical examples, and interpretation of results. A short section is devoted to the human response to mechanical vibration. Copies of this publication are available from the General Radio Company, 275 Massachusetts Avenue, Cambridge, Mass.

Replacement Guide. A revised selenium rectifier replacement guide, (*R2*), has been published by the Sarkes Tarzian Rectifier Division of Bloomington, Ind. Also available is a new 4-page, 3-color, condensed catalogue, *4C*, on the entire Sarkes Tarzian centre-kooled selenium rectifier line. Both booklets are available from: Sarkes Tarzian, Inc., Rectifier Division, 415 North College Avenue, Bloomington, Ind.

Receiving Tube Manual. A 336-page revised edition of the Radio Corporation of America (RCA) Receiving Tube Manual *RC-17*, now is available, covering technological advances in the electronics fields. One of this manuals features is a 26-page supplement covering 51 newly added tube types including types developed especially for use in television receiver circuits. The latest manual presents a section on electron tube theory, and tube characteristics and applications. Another section contains 22 circuit diagrams most commonly encountered by experimenters. Among the charts is one listing the operating characteristics of 64 RCA types of television picture tubes, including color tubes types *15GP22* and *21AXP22*. The tube manual may be obtained through RCA tube distributors, or by writing to Commercial Engineering, RCA Tube Division, Harrison, N. J. The price is 60 cents a copy.

Kellogg Booklet. The chemical structure, specifications, properties, applications, and general description of a new group of fluorocarbon oils, waxes, and greases for industrial use are described in a 16-page booklet, "KEL-F Fluorocarbon Oils, Waxes and Greases." Copies of this new booklet can be obtained by writing to: Chemical Manufacturing Division, The M. W. Kellogg Company, Post Office Box 469, Jersey City, N. J.

Catalogue on Kodak Contour Projectors. A new catalogue describing the six models of Kodak Contour Projectors now available has been prepared by the Eastman Kodak Company and is ready for distribution. The booklet discusses the use of optical gauging in the toolroom, in production, in receiving, and in final inspection. Copies of the catalogue are available, without charge, on request from Special Products Sales Division, Eastman Kodak Company, 343 State Street, Rochester, N. Y.

Fluid Pressure Cells Bulletin. *SR-4* fluid pressure cells and their uses in electrical measurement and control of pressure are presented in a new 16-page leaflet Bulletin *4306*, issued by Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa. Six standard types of cells in 25 sizes ranging from 15 to 50,000 pounds per square inch, as well as some special purpose cells, are included. Characteristics, principles of operation, instrumentation, and specifications are given.

Magnetic Shields Catalogue. Magnetics, Inc., of Butler, Pa. now offers a magnetic shields catalogue containing information on the large number of standard shields which the company manufactures. The catalogue *MS-104*, "Performance-Guaranteed Magnetic Shields," describes the shield alloys which are used, the dry hydrogen annealing process used for controlling shielding properties, and fabrication and finishes. Copies may be obtained by writing Magnetics, Inc., on letterhead stationery.

Maintenance and Service Manual. A 48-page manual on lead acid batteries for all types of motive power application has been issued by C and D Batteries Inc. Industrial cycle service is covered in its entirety, including industrial truck, marine service, mine locomotives, railroad diesel starting, and carlighting and air conditioning service. The manual is available without charge to interest battery users from the nearest local office or Manager, Headquarters Service, C and D Batteries, Inc., Washington and Cherry Streets, Conshohocken, Pa.

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Specification of performance characteristics of cable and cable accessories has in recent years become a matter of increasing scientific exactitude. Thorough engineering and control have replaced guesswork. In this development, Lapp is proud to have been able to provide ceramic design and production facilities apace of progress in the field.

On this piece, both ends, as well as the flange bearing surface, are ground for gasketing. To provide for dielectric grading, an area at the center is conductive-glazed, and the tapered surface is precision-ground for application of dielectric grading materials.

This is typical of but one of the many types of problems involving high-voltage insulation solved by Lapp. Lapp design and Lapp production methods add reliability and service life to equipment insulated by Lapp porcelain and Lapp porcelain-metal assemblies.

Porcelain by LAPP, in complicated special shapes, or in insulators for line and station use, is a guarantee of operating security, long life, low upkeep.

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